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Operations and Maintenance Manual for the Expanded Bioventing System Eglin Main Base Old Fire Training Area

Eglin Air Force Base
Florida

Prepared For

Air Force Center for Environmental Excellence
Technology Transfer Division
Brooks Air Force Base
San Antonio, Texas

and

AFDTC / EMR
Eglin Air Force Base
Florida

June 1998

726876/cover2

PARSONS
ENGINEERING SCIENCE, INC.

5390 Triangle Parkway, Suite 100, Norcross, Georgia 30092

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Operations and Maintenance Manual for the Expanded Bioventing System Eglin Main Base Old Fire Training Area

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Prepared By

PARSONS ENGINEERING SCIENCE, INC.
5390 Triangle Parkway
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Norcross, Georgia 30092

June 1998

CONTENTS

SECTION 1

INTRODUCTION

This Operations and Maintenance (O&M) Manual has been created as a guide for monitoring and maintaining the performance of the expanded bioventing blower system and vent well plumbing at the Eglin Main Base Old Fire Training Area (old Eglin FTA) at Eglin Air Force Base (AFB), Florida. This site is also identified as Installation Restoration Program (IRP) Site FT-28. Record drawings of the expanded bioventing system installed at site FT-28 are provided in Appendix A.

Bioventing is the forced injection of fresh air, or withdrawal of soil gas, to enhance the supply of oxygen in subsurface soils for *in situ* bioremediation. A blower system is used to inject air into the soil, thereby supplying fresh atmospheric air (with approximately 20.8 percent oxygen) to contaminated soils. Once oxygen is provided to the subsurface, existing bacteria aerobically break down fuel residuals. Aerobic biodegradation is much more efficient than anaerobic biodegradation which occurs in oxygen depleted soils.

Parsons Engineering Science, Inc. (Parsons ES) has installed a pilot-scale air injection bioventing system consisting of one air injection blower, one vent well (VW1), three soil gas monitoring points (MPs), and associated piping at the site. Following the installation and testing of a pilot-scale bioventing system from July 1994 through July 1995, Parsons ES installed an expanded (full-scale) bioventing system at FT-28 consisting of four additional vent wells (VW2 through VW5), three new MPs (MPD through MPF), a blower system, associated piping, controls, and electrical service. The existing vent well (VW1) and existing monitoring well FT28-03 were also connected to the expanded system to serve as vent wells. The three MPs (MPA through MPC) installed during the previous pilot testing efforts will continue to be used to monitor system performance. System operation was initiated on February 11, 1998. The air injection rates of the full-scale bioventing system were optimized at each vent well to assure adequate aeration of contaminated soils to promote aerobic biodegradation. Soil gas monitoring was performed in March 1998 to determine if the area designated for bioventing treatment was receiving an adequate supply of oxygen. At the time of the site visit the blower unit was not in operation. Soil gas monitoring indicated that, although the blower unit was not functioning, oxygen levels were greater than 10 percent in all of the monitoring points with the exceptions of MPC (shallow), MPC (intermediate), MPD (shallow), and MPF (deep). Parsons ES determined that the shut down of the blower unit may have been caused by the infiltration of moisture into the motor starter enclosure. Parsons ES fixed the enclosure to mitigate the potential for future infiltration of moisture and the blower unit was restarted on March 6, 1998.

Eglin AFB personnel are responsible for routine monitoring of the bioventing system. Parsons ES has trained Eglin AFB personnel on the maintenance requirements of this plan. If significant problems are encountered with the operation of the system, Parsons ES should be notified so repairs can be made. Under the Extended Bioventing Project Option 1, Parsons ES is

responsible for system repair for a 1-year period after system startup. Parsons ES will retain responsibility for system repair until February 1999. Should the bioventing system cease to operate or develop a significant problem, please call the Parsons ES Site Manager, Mr. Steve Ratzlaff, at (678) 969-2361, or the Parsons ES Project Manager, Mr. John Ratz, at (303) 831-8100. If the system ceases to operate, please have a base electrician verify that adequate power is being supplied to the bioventing system blower motor prior to notifying Parsons ES.

SECTION 2

SYSTEM DESCRIPTION

2.1 BLOWER SYSTEM

A Gast® R6P350A blower powered by a 5-horsepower direct drive motor was installed at site FT-28 on February 10, 1998. The R6 blower is rated as having a maximum flow rate of 290 standard cubic feet per minute (scfm) at open flow and a maximum pressure of 60 inches of water. As installed, the blower at site FT-28 was producing an estimated flow rate of 223 actual cubic feet per minute (acfm) at a pressure of 29 inches of water. Following the adjustment of VW air injection rates, approximately 35 acfm is being injected into vent wells VW1 through VW5 and approximately 43 acfm is being injected into FT28-03. The blower system includes an inlet air filter to remove any particulates which are entrained in the inlet air stream and several valves and monitoring gauges which are described in Section 2.2. A schematic of the expanded blower system installed at site FT-28 is shown in Appendix A. Corresponding blower performance curves and relevant service information are provided in Appendix B. Blower system data collection sheets for use by facility personnel are provided in Appendix C.

2.2 MONITORING AND FLOW CONTROL EQUIPMENT

2.2.1 Monitoring Gauges

The bioventing system is equipped with vacuum, pressure, and temperature gauges, and air velocity measurement ports. Gauges have been installed on the air injection system at the following locations: a vacuum gauge in the inlet piping and pressure and temperature gauges in the outlet piping.

2.2.2 Flow Control Equipment

Manual and automatic flow control valves (FCVs) have been installed on the bioventing blower system. Manual FCVs have been installed in the piping leading to each VW to enable the flow rate to each VW to be adjusted individually. An automatic FCV, or pressure relief valve (PRV), is used to protect the blower system from burning out if pressures rise due to pipe blockage. The PRV is set to bleed off flow at a preset pressure and thus prevent blower outlet pressure from ever exceeding the rated pressure.

An additional FCV (bleed valve) has been installed to control the total air flow out of the blower by releasing excess air flow to the atmosphere. The FCVs have been set by Parsons ES personnel to deliver a calculated amount of air to each VW and should not be adjusted unless directed to do so by Parsons ES personnel.

The blower system has also been equipped with flow measurement ports. These ports consist of brass bushings installed in the outlet piping leading to each VW. These bushings, which should be plugged during system operation, allow the insertion of a thermal anemometer for the measurement of air velocity. These ports are used by Parsons ES for system optimization.

Although the blower system installed at site FT-28 is relatively maintenance free, periodic system maintenance is required for proper operation and long life. Recommended maintenance procedures and schedule are described in detail in the instruction manuals included in Appendix B and briefly summarized in this section.

Filter inspection must be performed with the system turned off. Do not change the flow control valve settings (valves have been pre-set for a specific flow rate) before re-starting the blower.

SECTION 3

SYSTEM MAINTENANCE

3.1 BLOWER/MOTOR

The blower and motor are relatively maintenance free and should not require any maintenance during the operational period. Both the blower and motor have sealed bearings and do not require lubrication.

3.2 AIR FILTER

To avoid damage caused by passing solids through the blower, an air filter has been installed in-line before the blower. The filter should be checked weekly for the first 2 months of operation. A facility employee should determine the best schedule for filter replacement based on the first 2 months of system monitoring. If polyurethane pre-filters accompany the paper filter element, these can be washed with lukewarm water and a mild detergent. Paper filter elements should never be washed, and should be disposed of and replaced as necessary. When the vacuum drop across the filter increases by approximately 5.5 inches of water from the vacuum when the filter was new, a dirty filter element should be suspected, and cleaning or replacement should be performed. The initial vacuum when the filter element was new was 7 inches of water. Therefore, the filter should be cleaned or replaced when the vacuum increases to 12.5 inches of water. Typical filter element replacement intervals range from 3 to 6 months.

To remove the filter, turn the system off by switching the power off at the disconnect switch enclosure (located on the electric riser approximately 10 feet northwest of the blower shed), loosen the wing nut on the filter top, lift the metal top off the air filter, and lift the air filter element from the metal housing. Remove the polyurethane pre-filter (if applicable) and wash before replacing.

The filter element is manufactured by Solberg Manufacturing, Inc. in Itasca, Illinois. Their toll free telephone number is 1-800-451-0642. Additional filters can also be obtained through Parsons ES. The Parsons ES contacts are Mr. Steve Ratzlaff, at (678) 969-2361, and Mr. John Ratz, at (303) 831-8100. The part number for the replacement filter element is F-230S-300. Four spare air filter elements have been placed inside the blower enclosure.

3.3 MAINTENANCE SCHEDULE

The following maintenance schedule is recommended for the blower system. During the initial few months of operation more frequent monitoring is recommended to ensure that any startup problems are quickly corrected. A daily drive-by inspection is recommended during the initial 2 weeks of operation to ensure that the blower system is still operating with no unusual

sounds. Thereafter monitoring inspections every 2 weeks are recommended (see Section 4). Preprinted data collection sheets have been provided to the facility. Extra data collection sheets for recording maintenance activities are provided in Appendix C.

Maintenance Item	Maintenance Frequency
Filter	Check once every 2 weeks, wash or replace as necessary (see Section 3.3). Inlet vacuum exceeding 12.5 inches of water indicates that the filter requires cleaning or replacement.

3.4 MAJOR REPAIRS

Blower systems are very reliable when properly maintained. Occasionally, however, a motor or blower will develop a serious problem. If a blower system fails to start, and a qualified electrician verifies that power is available at the blower or starter, Parsons ES should be contacted to arrange for repairs. The Parsons ES contacts are Mr. Steve Ratzlaff, at (678) 969-2361, and Mr. John Ratz, at (303) 831-8100. Parsons ES is responsible for major repairs during the first year of operation.

SECTION 4

SYSTEM MONITORING

4.1 BLOWER PERFORMANCE MONITORING

To monitor the blower performance, the vacuum, pressure, and temperature will be measured. These data should be recorded every 2 weeks on a data collection sheet (provided in Appendix C). All measurements should be taken at the same time while the system is running. Because the systems are noisy, hearing protection should be worn at all times.

4.1.1 Vacuum/Pressure

With hearing protection in place, unlock and open the blower enclosure and record all vacuum and pressure readings directly from the gauges (in inches of water). Record the measurements on the data collection sheet.

4.1.2 Temperature

With hearing protection in place, open the blower enclosure and record the temperature readings directly from the gauges in degrees Fahrenheit (°F). Record the measurements on a data collection sheet (provided in Appendix C). The temperature change can be converted to degrees Celsius (°C) using the formula °C= (°F - 32) × 5/9.

4.2 MONITORING SCHEDULE

The following monitoring schedule is recommended for these systems. During the initial month of operation, more frequent monitoring is recommended to ensure that any start up problems are quickly corrected. Data collection sheets have been provided to assist your data collection and are included in Appendix C.

Monitoring Item	Monitoring Frequency
Vacuum/Pressure	Once every 2 weeks.
Temperature	Once every 2 weeks.

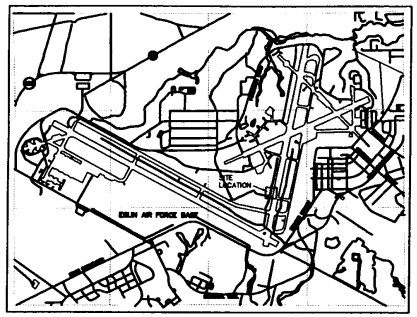
4.3 REPORTING MONITORING RESULTS

System monitoring data sheets should be faxed to the Parsons ES Site Manager, Mr. Steve Ratzlaff at (678) 969-2361, once every 2 months. However, if a significant change in the system temperature or pressure is noted (such as a significant drop or increase in pressure) please call

Mr. Ratzlaff immediately. A significant change in system temperature or pressure may be indicative of a problem with the air delivery system or blower.

APPENDIX A

RECORD DRAWINGS



LOCATION MAP
NOT TO SCALE

RECORD DRAWINGS FOR

EXPANDED BIOVENTING SYSTEM
EGLIN MAIN BASE OLD FTA
EGLIN AIR FORCE BASE

PREPARED FOR

AFCEE

JUNE 1998

DRAWING INDEX

DRAWING NO	DRAWING NAME
G-0.1	TITLE SHEET AND SITE LAYOUT
G-0.2	LEGEND AND STANDARD TRENCH DETAIL
G-0.3	VENT WELL AND MONITORING POINT STANDARD DETAILS
G-0.4	BLOWER P & ID
G-0.5	BLOWER PIPING LAYOUT DETAIL
G-0.6	BLOWER SHED FIELD INSTALLATION DETAIL AND BLOWER SHED CONSTRUCTION DETAIL

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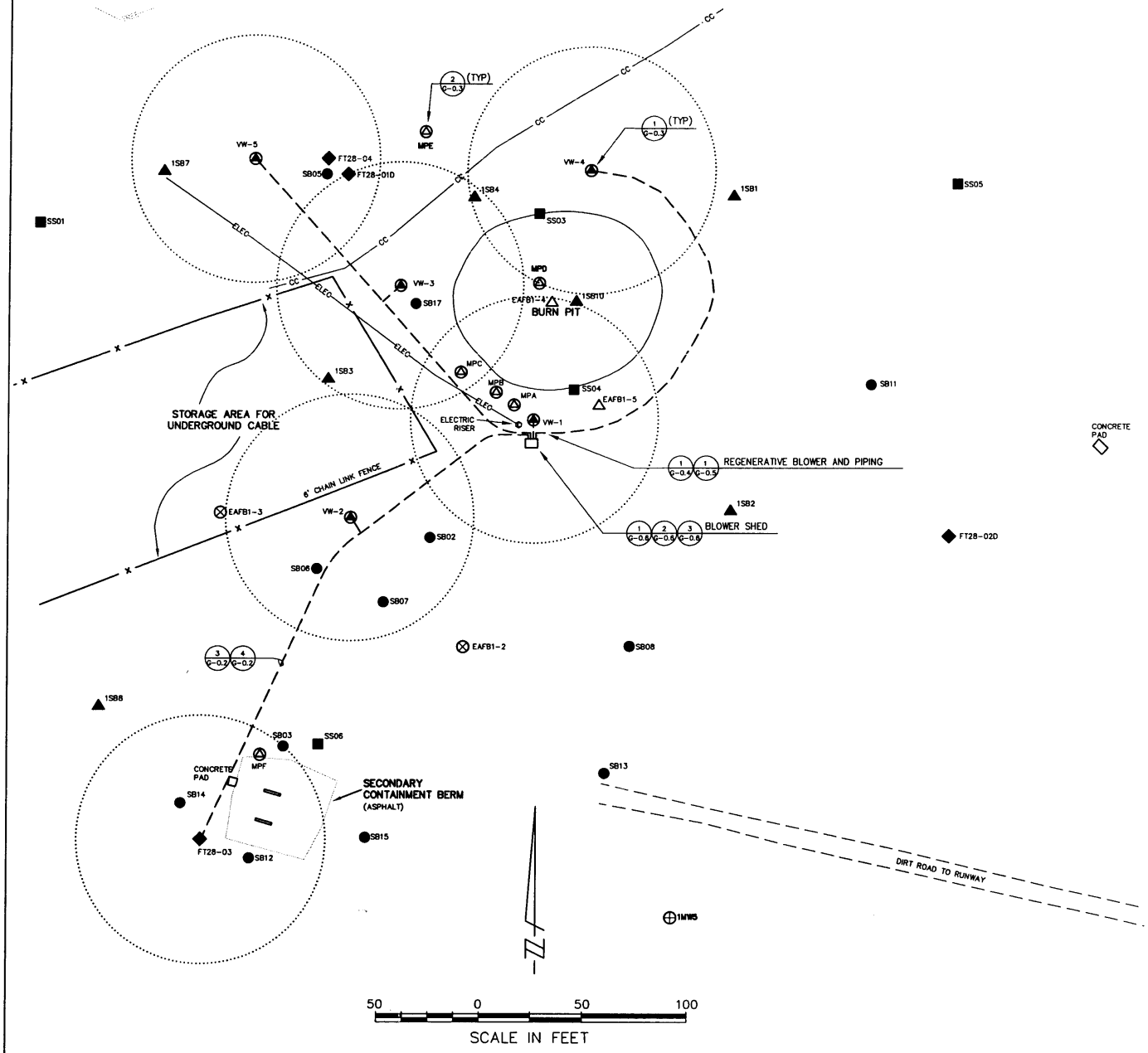

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AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
EGLIN MAIN BASE OLD FTA
EGLIN AIR FORCE BASE

TITLE SHEET AND SITE LAYOUT

DRAWING NO	REV
G-0.1	B

ABBREVIATIONS

AIJ	AIR INJECTION
APPROX	APPROXIMATE
ASTM	AMERICAN SOCIETY OF TESTING AND MATERIALS
&	AND
@	AT
BGS	BELOW GROUND SURFACE
CBM	CENTER BACK MOUNT
CFM	CUBIC FEET PER MINUTE
CLR	CLEAR
DIA	DIAMETER
EB	EXPLORATORY BORING
ECC	ECCENTRIC
EW	EACH WAY
FOT	FLAT ON TOP
FPT	FEMALE PIPE THREAD
FT	FOOT
GALV	GALVANIZED STEEL
HDPE	HIGH DENSITY POLYETHYLENE
ID	INNER DIAMETER
ie	FOR EXAMPLE
LM	LOWER MOUNT
MAX	MAXIMUM
MIN	MINIMUM
MP	MONITORING POINT
MPT	MALE PIPE THREAD
NO, #	NUMBER
NPT	NATIONAL PIPE THREAD
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
PVC	POLYVINYL CHLORIDE
PW	PROPOSED WELL
RED	REDUCER
REF	REFERENCE
SCH	SCHEDULE
S	SOCKET
SPVC	SLOTTED POLYVINYL CHLORIDE
ST STL	STAINLESS STEEL
TYP	TYPICAL
UST	UNDERGROUND STORAGE TANK
VW	VENT WELL
W/	WITH
WN	WELD NECK
WWF	WELDED WIRE FABRIC

SYMBOLS

- EAFB1-5 △ PHASE II, STAGE 2 SOIL BORING APPROXIMATE LOCATION (1986)
- EAFB1-3 ⊗ PHASE II, STAGE 2 MONITORING WELL APPROXIMATE LOCATION (1986)
- 1MW4 ⊕ PHASE II, STAGE 3 SHALLOW MONITORING WELL APPROXIMATE LOCATION (1988)
- 1MW3 ⊞ PHASE II, STAGE 3 DEEP MONITORING WELL APPROXIMATE LOCATION (1988)
- 1SB2 ▲ PHASE II, STAGE 3 SOIL BORING APPROXIMATE LOCATION (1988)
- SB07 ● RFI SOIL BORING LOCATION (1995)
- SS06 ■ RFI SURFACE SOIL SAMPLING LOCATION (1995)
- FT28-07 ◆ RFI MONITORING WELL LOCATION (1995)
- VW-3 ⊛ BIOVENTING VENT WELL
- MPC ⊛ BIOVENTING VAPOR MONITORING POINT
- — — — HEADER PIPE TO VENT WELL
- ····· VENT WELL RADIUS OF INFLUENCE
- ——X—— CHAIN LINK FENCE
- ——ELEC—— BURIED ELECTRICAL CABLE
- ——CC—— BURIED COMMUNICATIONS CABLE

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MATERIAL LEGEND

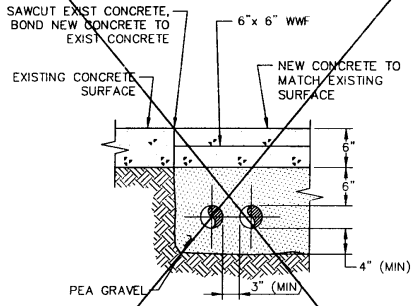
- ASPHALT
- BENTONITE
- BENTONITE/CEMENT GROUT
- BENTONITE PELLETS
- BUILDING (EXISTING)
- COMPACTED BACKFILL
- COMPACTED BASE STONE
- CONCRETE
- PEA GRAVEL
- SAND
- UNDISTURBED SOIL

PIPE MATERIAL

CS	CARBON STEEL
GALV	GALVANIZED STEEL
PVC	POLYVINYL CHLORIDE
SPVC	SCREENED POLYVINYL CHLORIDE

PIPE SERVICE

AIJ	AIR INJECTION
BIV	BIOVENTING
DR	DRAIN



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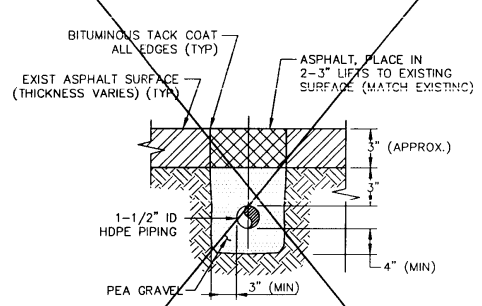

ASPHALT REPLACEMENT DETAIL
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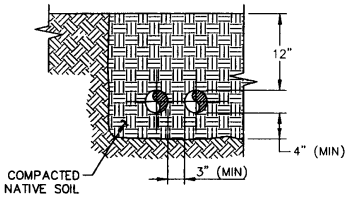
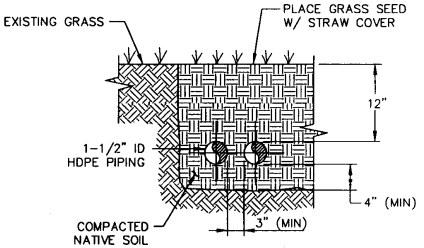


SOIL COVER REPLACEMENT DETAIL
3 / G-0.1
SCALE: NTS



GRASS COVER REPLACEMENT DETAIL
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AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
EGLIN MAIN BASE OLD FTA
EGLIN AIR FORCE BASE

LEGEND AND STANDARD TRENCH DETAILS

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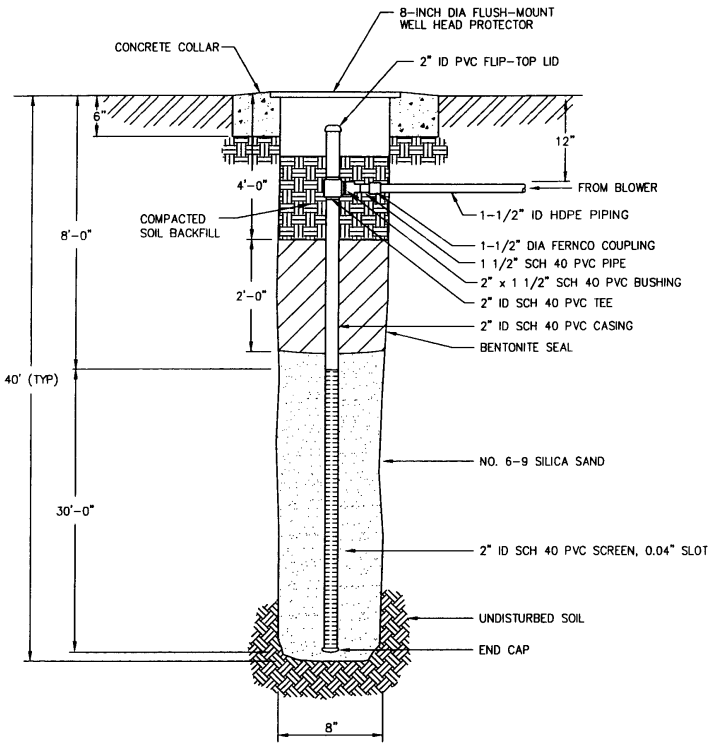
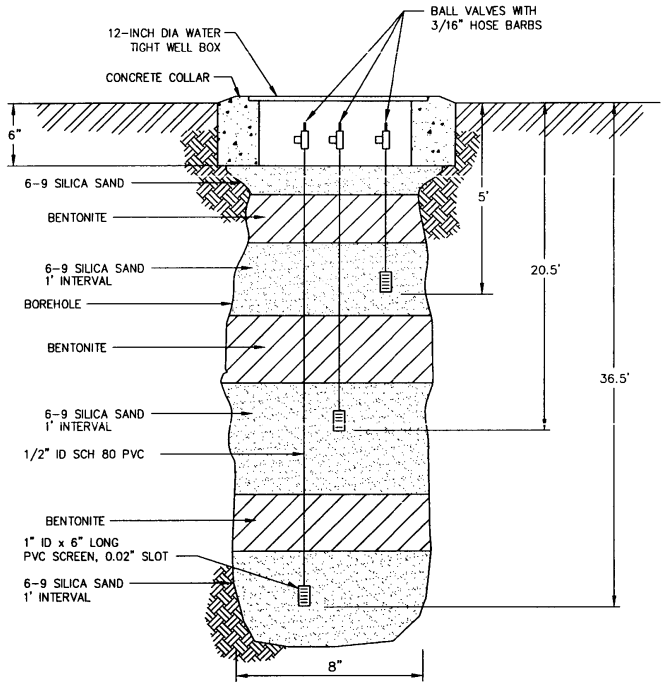


1 / G-0.1 VENT WELL (VW) DETAIL

SCALE: NTS

NOTE: VW-5 – SCREENED INTERVAL = 5-35 FT BGS
BENTONITE INTERVAL = 2-4 FT. BGS
SAND INTERVAL = 4-35 FT BGS



2 / G-0.1 MONITORING POINT (MP) DETAIL

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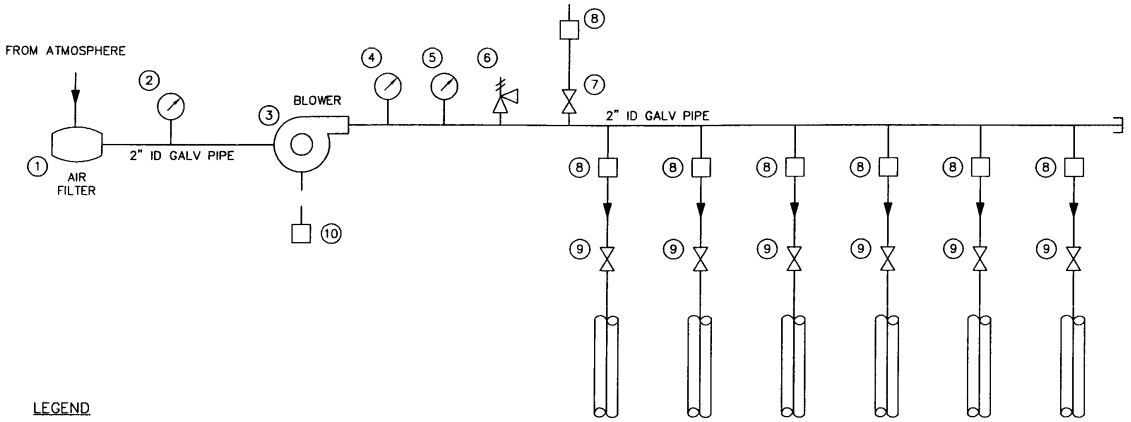
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
HURLBURT FIELD FTA
EGLIN AIR FORCE BASE

VENT WELL AND MONITORING POINT STANDARD DETAILS

DRAWING NO G-0.3 | REV B



LEGEND

(1) INLET AIR FILTER – SOLBERG F-230S-300 W/3"MPT, REPLACEMENT ELEMENT 230S

(2) VACUUM GAUGE – GAST® 2 5/8" DIA, 0-60" H_2O, 1/4" NPT, LM
(Part No. AJ497)

(3) BLOWER – GAST® 5.0 HP R6P350A, 200 CFM AT 60" H_2O PRESSURE

(4) TEMPERATURE GAUGE – ASHCROFT, 0-250°F, 1/2" NPT, CBM
(Part No. 2A606 FROM GRAINGER)

(5) PRESSURE GAUGE – WIKA 611.10, 2 1/2" DIA., 0-60" H_2O, 1/4" NPT, LM
(Part No. 9851704)

(6) AUTOMATIC PRESSURE RELIEF VALVE – GAST AG258, SET TO RELEASE AT 40" H_2O PRESSURE

(7) MANUAL PRESSURE RELIEF (BLEED) VALVE – 1 1/2" NPT GATE VALVE

(8) FLOW MEASURING PORT FITTED WITH PLUG (1/4" x 1/8" NPT BRASS REDUCING BUSHING, 1/8" NPT BRASS PLUG)

(9) FLOW CONTROL VALVE – 1 1/2" GATE VALVE

(10) STARTER

NOTES

(1) ALL PIPING 1 1/2" ID, GALVANIZED STEEL, UNLESS OTHERWISE NOTED.

(1 / G-0.1) BLOWER PIPING AND INSTRUMENTATION DIAGRAM

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EXPANDED BIOVENTING SYSTEM
EGLIN MAIN BASE OLD FTA
EGLIN AIR FORCE BASE

BLOWER P & ID

DRAWING NO G-0.4

REV B

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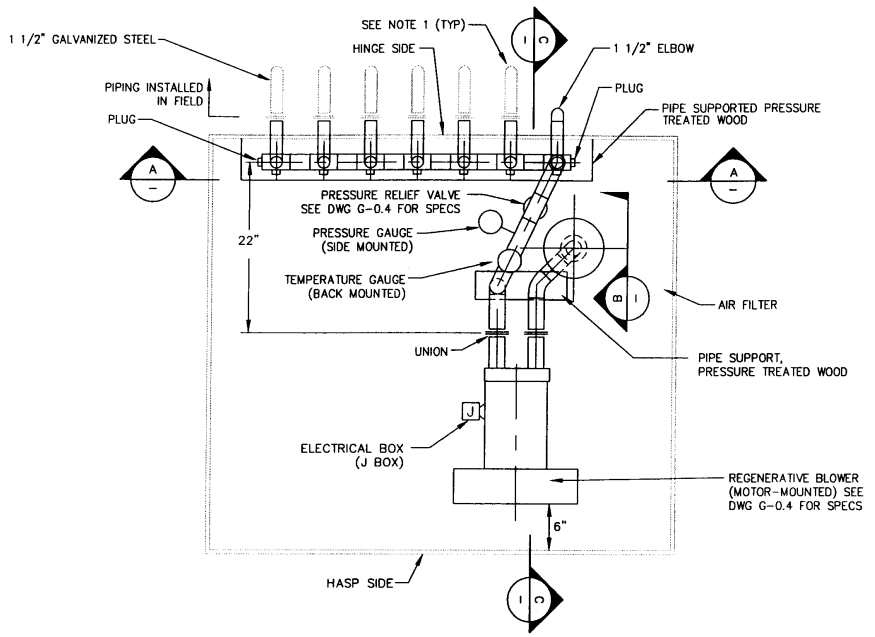
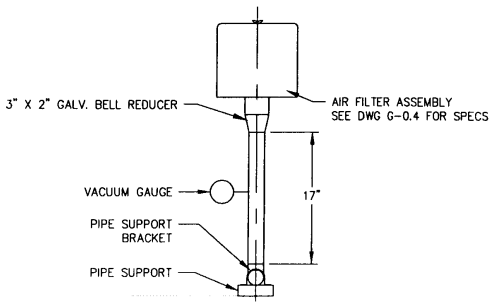
NOTES:

1. SHOP CORE HOLES TO PIPING DIMENSIONS
2. ALL PIPING 2" ID GALVANIZED STEEL, UNLESS OTHERWISE NOTED
3. SEE DRAWING G-0.6 FOR BLOWER BUILDING DETAILS



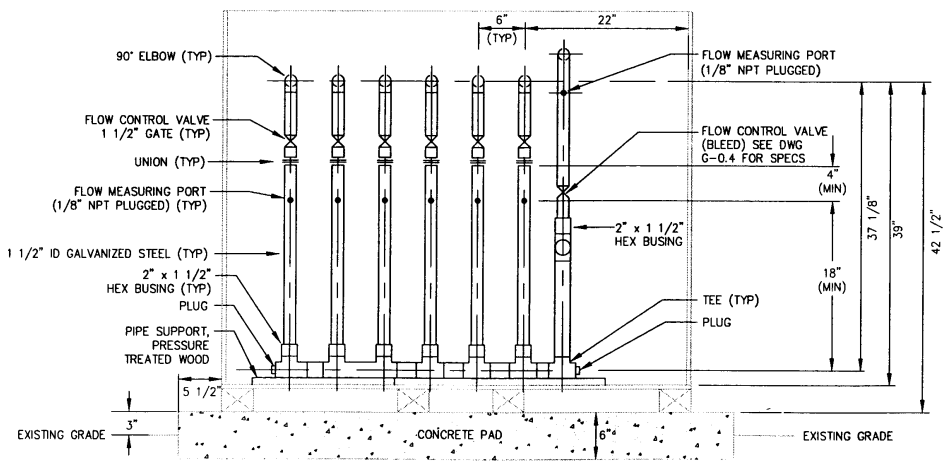
1 / G-0.1 BLOWER PIPING LAYOUT PLAN DETAIL

3/4" = 1'-0"



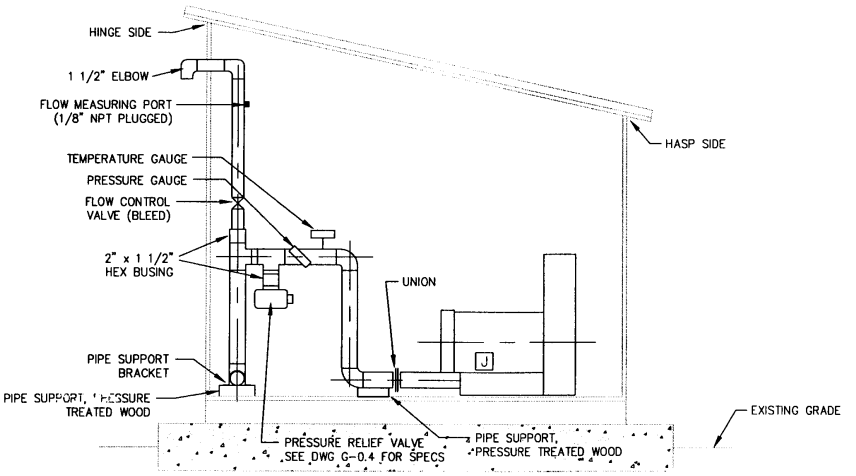
B / — BLOWER INLET PIPING SECTION

3/4" = 1'-0"



A / — MANIFOLD DETAIL SECTION

3/4" = 1'-0"



C / — BLOWER OUTLET PIPING SECTION

3/4" = 1'-0"

Job No. 726876.43242						
Designed SAR						
Drawn CPC						
Checked						
Reviewed						
Approved				B	6/98	RECORD DRAWING
Reg No				Rev	Date	Description By
Date						

PARSONS ENGINEERING SCIENCE, INC.
Norcross, Georgia (770) 446-4900

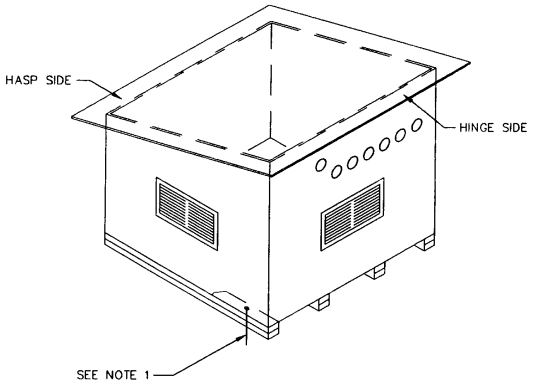
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
EGLIN MAIN BASES OLD FTA
EGLIN AIR FORCE BASE

BLOWER PIPING LAYOUT DETAIL

DRAWING NO G-0.5 | REV B

J:\726876\Cadd\oldegfta\960N0196A2, 06/15/98 at 09:39

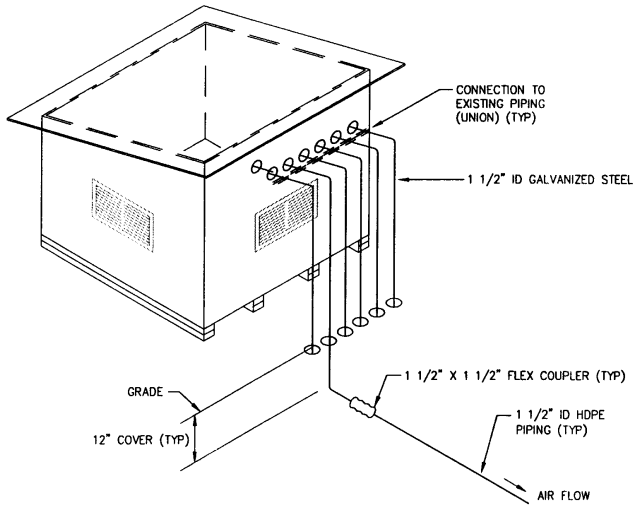


NOTE:

1. BLOWER SHED SECURED TO CONCRETE PAD AT LOCATIONS BY THRU BOLTING.

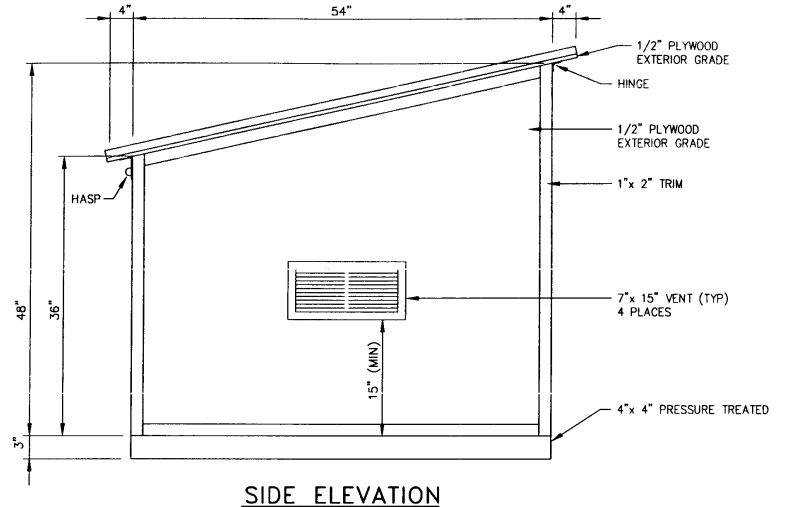
1 / G-0.1 BLOWER SHED FIELD INSTALLATION DETAIL

NOT TO SCALE

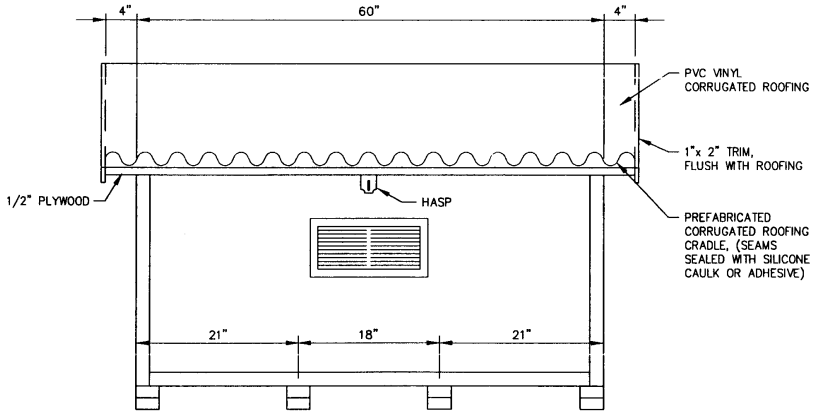


2 / G-0.1 TYPICAL MANIFOLD DISCHARGE PIPING LAYOUT

NOT TO SCALE



SIDE ELEVATION



FRONT ELEVATION

NOTES:

1. 2"x 2" FRAME CONSTRUCTION
2. FLOOR CONSTRUCTED OF 3/4" EXTERIOR GRADE PLYWOOD
3. ROOF CONSTRUCTED OF 1/2" EXTERIOR GRADE PLYWOOD COVERED WITH PVC VINYL CORRUGATED ROOFING

3 / G-0.1 BLOWER SHED CONSTRUCTION DETAIL

3/4" = 1'-0"

J:\726876\Cadd\oldegfta\96DN0197A2, 06/16/98 at 09:15

Job No. 726876.43242
Designed SAR
Drawn CPC
Checked
Reviewed
Approved
Reg No
Date

Rev	Date	Description	By
B	6/98	RECORD DRAWING	

PARSONS ENGINEERING SCIENCE, INC.
Norcross, Georgia (770)446-4900

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
EGLIN MAIN BASE OLD FTA
EGLIN AIR FORCE BASE

BLOWER SHED FIELD INSTALLATION DETAIL AND BLOWER SHED CONSTRUCTION DETAILS

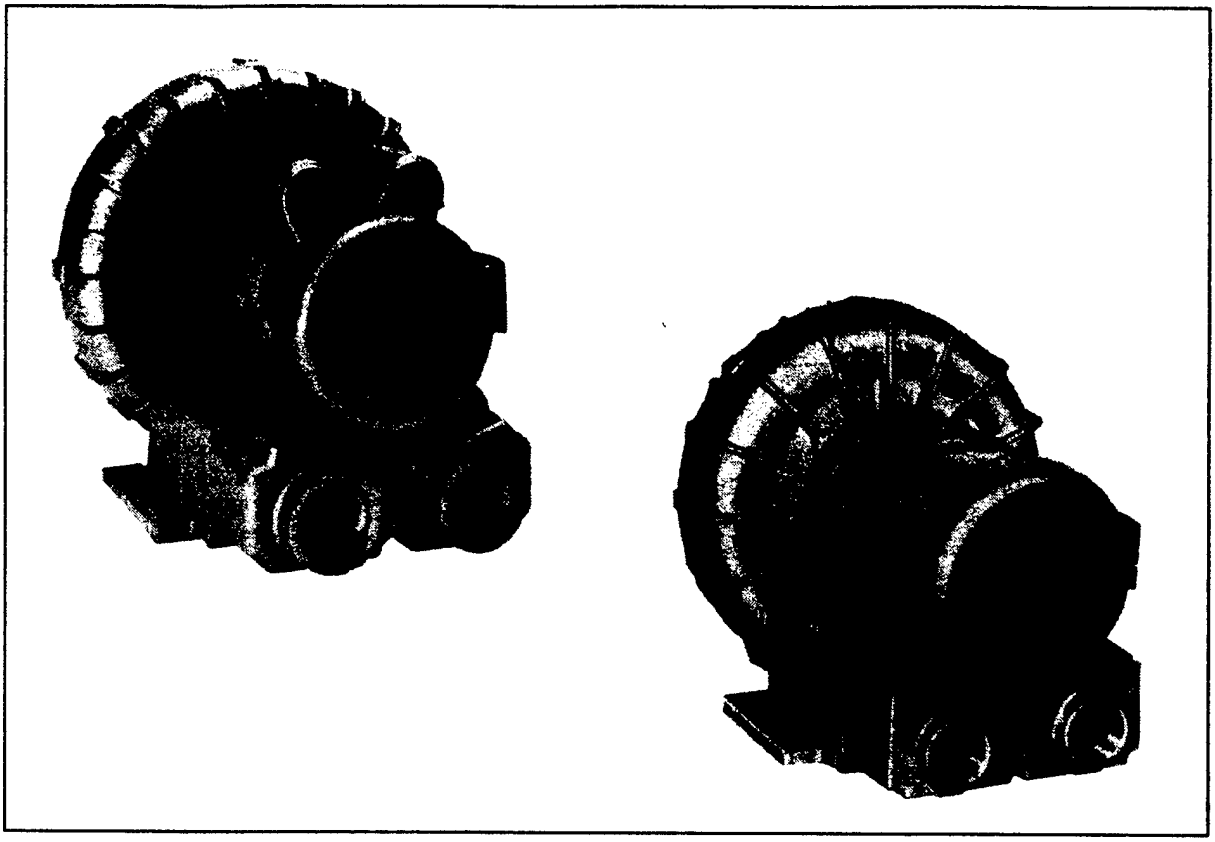
DRAWING NO G-0.6 | REV B

APPENDIX B

REGENERATIVE BLOWER INFORMATION

70-6000 F2-200 (Rev. C)

STANDARD REGENAIR BLOWER OPERATION AND MAINTENANCE TECHNICAL MANUAL



CONTENTS:

KEEP THIS DOCUMENT FOR FUTURE REFERENCE

This is the hazard alert symbol: ⚠ When you see this symbol be aware that personal injury or property damage is possible. The hazard is explained in the text following the symbol. Read the information carefully before proceeding.

The following is an explanation of the three different types of hazards:

⚠ **DANGER** Severe personal injury or death will occur if hazard is ignored.

⚠ **WARNING** Severe personal injury or death can occur if hazard is ignored.

⚠ **CAUTION** Minor injury or property damage can occur if hazard is ignored.

GENERAL INFORMATION

These instructions do not apply to:

1) Blowers without motors, SDR Series.
2) The M & H Series, model number with M or H as third character.
3) Blowers powered with Explosion Proof Motors.

This blower is only to be used for the purpose of pumping air and under no circumstances be used with any other gases. The blower must not be used for the pumping of fluids, particles, solids, or any substance likely to cause fire or explosion.

⚠**WARNING** Do not pump flammable or toxic gases or operate the pump in an atmosphere containing them. Severe personal injury can occur if hazard is ignored.

⚠**WARNING** Keep hands or other body parts away from the blower suction. Failure to do so could result in personal injury.

⚠**CAUTION** Required ambient temperature for normal operation should not ex ceed 40°C (105 ° F). For higher ambient operation, consult the factory. Failure to do so could result in fire or property damage.

⚠**CAUTION** Blowers may generate heat. To prevent bums, do not touch blower during operation or until unit has cooled.

Blower performance is reduced by lower atmospheric pressure found at high altitudes, consult the factory or a Gast distributor for details.

INSTALLATION

IMPORTANT: Remove any plastic caps before starting blower. Any foreign material (burrs, chips, welding drops, slag, pipe cuttings, excess sealant, sand, lime, etc.) must be removed, or filtered out. Any such material, no matter how small, that enters the blower can damage it. Clean out new plumbing before attaching to blower inlet.

WIRING

⚠**WARNING** Electrical shock or fire hazard can result from incorrect wiring. Wiring must conform to all required safety codes and be installed by a qualified person. Grounding is required.

Fuses protect the wiring against short circuits. On motors without Automatic restart, thermal protection or magnetic over-current cut-outs are absolutely necessary to prevent motor overloading. This is due to the following, one phase in a three phase electric system, high starting frequency, or jammed blower. Required power will rise as differential pressure increases. For motor wiring diagram see inside of the conduit box or motor nameplate. Large motors may have two nameplates, one for 50Hz, the other for 60Hz. Be sure that all dual-voltage motors are wired for your power source.

MOUNTING THE PUMP

The single impeller blower may be installed in any orientation as long as the flow of cool, ambient air over the pump is not blocked. The dual impeller models must be mounted with the shaft horizontal.

The flow of cooling air over the blower and motor must not be blocked. It is very important to install the blower in a well ventilated area where the temperature does not exceed 40°C. Check this temperature after the blower has been running for an hour.

Strong forced ventilation is often needed for the larger blowers. In vacuum service the hot discharge air of larger blowers, must be plumbed away to avoid overheating the room or enclosure where the blower is located. Discharge excess air into atmosphere, through a relief valve.

ROTATION

The blower should only rotate clockwise as viewed from the motor side. This is marked with an arrow on most castings. Proper rotation can be confirmed by checking air flow at the IN and OUT ports. On blowers powered by a 3 phase motor, rotation can be reversed by changing any two of the power lines.

PLUMBING

Connect motor and check direction of rotation before connecting plumbing. The threaded pipe ports are designed as connection ports only and will not support the plumbing. Be sure to use the same or larger size pipe and fittings to prevent air flow restriction and overheating of the blower.

⚠CAUTION Attach blower to solid surface before starting, to prevent injury or damage from unit movement.

When installing plumbing, be sure to use a small amount of pipe thread lubricant. This protects the threads in the aluminum blower. When installing two blowers in parallel, use plumbing two whole pipe sizes larger in diameter than that of the blower.

ACCESSORIES

⚠CAUTION Blower must be installed with a proper sized inlet filter, gauge, and relief valve. Failure to do so may damage blower. Consult the factory or see a Gast distributor for recommendations.

Keep in mind filters progressively increase losses, due to clogging. Install a vacuum gauge to monitor filter restriction. Install a relief valve to avoid overloading of large blowers, caused by changes in pressure or vacuum.

Do not install check valves that close with a strong spring due to their large pressure loss. We recommend the check valves listed in the accessory section (page 6). They have minimal pressure drop, positive sealing, and are resistant to the high discharge temperatures of large blowers.

OPERATION

⚠CAUTION Avoid running blowers larger than R4 size, with no air flow through them. Protect with Gast recommended pressure or vacuum relief valve. Failure to do so will damage the blower.

⚠WARNING Solid or liquid material exiting the blower or piping can cause eye or skin damage. Keep away from air stream.

⚠WARNING Some of these models may exceed 85 dB(A). When in close proximity to these models hearing protection is required. See Technical Data Sheet (if provided), for specific model(s).

Do not exceed maximum pressure or vacuum capabilities marked on data label of unit.

Fit correct sized pipes and choose accessories that reduce to a minimum air friction load loss. Do not throttle discharge or suction pipe to reduce capacity. Throttling increases differential pressure, which consequently increases power absorption and working temperature. When the blower is ran at duties above 125mbar (50" H_2O) metal pipe may be required for the hot exhaust air.

⚠CAUTION Air temperature increases when passing through the blower. Outlet piping can cause burns. Access to these hot temperature areas should be guarded, limited, or marked "HOT".

Once the blower is in operation, check the following:
-Working pressure and vacuum values.

-Relief valve pressure or vacuum setting, adjust if needed.

-Measure motor current and compare with motor name plate data.

-Rated electrical overload cut-out.

-Check the ambient and discharge air temperatures to be sure they do not exceed allowed values one hour after starting. Exhaust Air should not exceed 230° F for all blowers except; R6PS and R7S models.

MAINTENANCE and INSPECTION

⚠WARNING Power must be de-energized and disconnected before servicing. Be sure all rotating parts have stopped. Electric shock or severe cuts can result if hazard is ignored.

The noise absorbing foam used in mufflers needs to be periodically replaced. The electric motor and blower also need periodic cleaning to remove accumulated dust & dirt. If they are not cleaned, this can result in excessive vibration, an increase in temperature, or can reduce the service life of the blower. Initial inspection is suggested at 8000 hours, then the user should determine the frequency.

An increase in the differential pressure across an inlet filter indicates its getting clogged. Clean the inlet air filter as often as needed, blowing down against the current to clean it. Change the cartridge when cleaning no longer gets the cartridge clean.

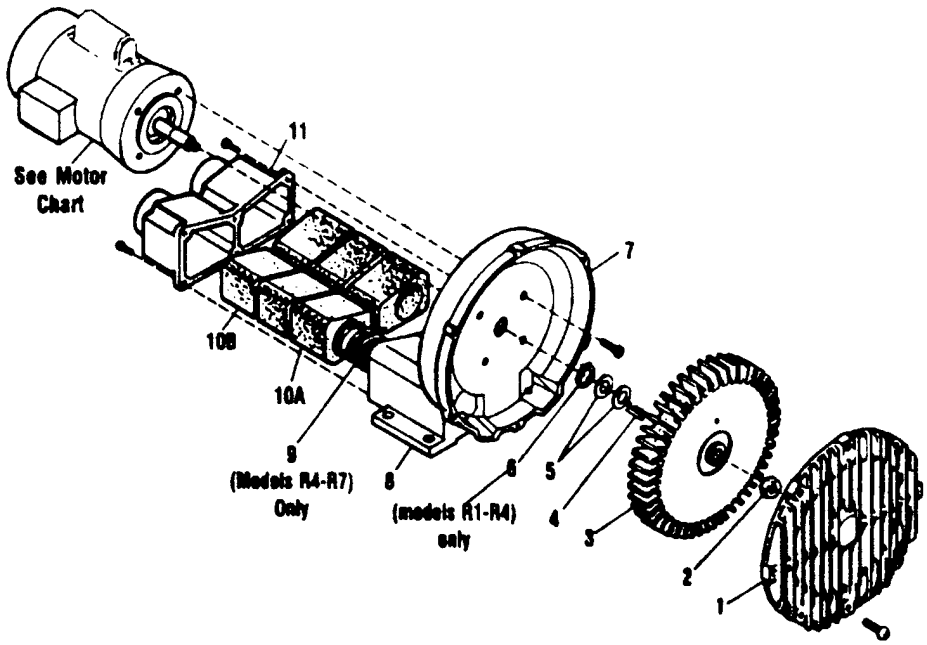
A dirty cartridge causes a high intake resistance 65' resulting in an increase of differential pressure, absorbed power, and working temperature.

The motor bearings of small motors (Less than 5112 HP,refer to motor nameplate), are greased for long life. Large motors (51/2 HP or larger, refer to 60 Hz motor nameplate), are equipped with alemite grease fittings. To relubricate these bearings clean tip of grease gun and apply the grease to the fitting. Use one or two strokes of Shell Dolium R grease.

Motor Bearing Re-Lubrication
(5 1/2 HP or larger)

Hours of Service per year	Suggested Relubrication Interval
5,000	3 years
Continual Normal Application	1 year
Seasonal service (motor idle for 6 mos. or more)	1 year at beginning of season
Continuous-high ambients, dirty or moist applications	6 months

Gast will not guarantee a field rebuilt pump. If repairs are needed contact or send blower to a Gast authorized service facility .



PARTS ORDERING INFORMATION

Ref. No.	Description	Part Qty	R1102	R2103 R2303A	R3105-1 R3305A-1	R3105-12	R4110-2 R4310A-2	R4P115 R4P315A
1	Cover	1	AJ101A	AJ101B	AJ101C	AJ101C	AJ101D	AJ101L
2	Stopnut	1	BC187	BC187	BC181	BC181	BC181	BC181
3	Impeller	1	AJ102A	AJ102BQ	AJ102C	AJ102CA	AJ102D	AJ102L
4	Square Key	1	AH212C	AH212	AB136A	AB136A	AB136D	AB136
5	Shim Spacer	As Req.	AE686-5	AE686-3	AJ109	AJ109	AJ109	AJ109
6	Retaining Ring	1	AJ145	AJ145	AJ149	AJ149	AJ149	-
7	Housing	1	AJ103A	AJ103BQ	AJ103C	AJ103C	AJ103DR	AJ103L
8	Muffler Box	1	-	-	-	-	-	AJ113DQ
9	Spring	2	-	-	-	-	AJ113DR	AJ113DQ
10A	Foam	As Req.	(4)AJ112A	(4)AJ112B	(4)AJ112C	(4)AJ112C	(4)AJ112DS	AJ112ER
10B	Foam	2	-	AJ112BQ	AJ112CQ	AJ112CQ	AJ112DR	-
11	Muffler Extension	1	AJ106A	AJ106BQ	AJ106CQ	AJ106CQ	AJ106DQ	AJ106FR

Parts listed are for stock models. For specific OEM models consult the factory.
When corresponding or ordering parts, please give complete model and serial numbers.

PARTS ORDERING INFORMATION

Ref. No.	Description	Part Qty	R5325A-2 R5125-2	R6350A-2 R6335A-2	R6P335A	R6P355A	R7100A-2	R7P3160M R7S3160M
1	Cover	1	AJ101EQ	AJ101FB	AJ101K	AJ101KA	AJ101G	AJ101G
2	Stopnut	1	BC181	BC181	BC181	BC182	BC183	BC183
3	Impeller	1	AJ102E	AJ102FR	AJ102K	AJ102KA	AJ102GA	AJ102GA
4	Square Key	1	AB136	AB136	AB136	AB136	AC628	AC628
5	Shim Spacer	As Req.	AJ109	AJ109	AJ109	AJ169	AJ110	AJ110
6	Retaining Ring	1	-	-	-	-	-	-
7	Housing	1	AJ103EQ	AJ103FQ	AJ103K	AJ103KA	AJ103GA	AJ103GA
8	Muffler Box	1	-	-	AJ104K	AJ104K	AJ104GA	-
9	Spring	2	AJ113DQ	AJ113FQ	AJ113FQ	AJ113FQ	AJ113G	-
10A	Foam	As Req.	(6)AJ112ER	(6)AJ112FC	(8)AJ112K	(8)AJ112K	(8)AJ112GA	-
10B	Foam	2	-	-	-	-	-	-
11	Muffler Extension	1	AJ106EQ	AJ106FR	-	-	-	-

Parts listed are for stock models. For specific OEM models consult the factory.
When corresponding or ordering parts, please give complete model and serial numbers.

RECOMMENDED ACCESSORIES

Discription	R1	R2	R3	R4	R5	R6 R6P	R6PS	R7
Inlet Pressure Filter	AJ126B	AJ126B	AJ126C	AJ126D	AJ126D	AJ126F	AJ126G	AJ126G
Replacement Element (Pressure)	AJ134B	AJ134B	AJ134C	AJ134E	AJ134E	AG340	AJ135A	AJ135A
Inline Vacuum Filter	AJ151A	AJ151B	AJ151C	AJ151D	AJ151E	AJ151G	AJ151H	AJ151H
Replacement Element (Vacuum)	AJ135D	AJ135E	AJ135E	AJ135E	AJ135F	AJ135G	AJ135C	AJ135C
Muffler	AJ121B	AJ121B	AJ121C	AJ121D	AJ121D	AJ121F	AJ121F	AJ121G
Horizontal Swing Type Check Valve	AH326B	AH326B	AH326C	AH326D	AH326D	AH326F	AH326F	AH326G

Pressure/Vacuum Gauges

- Pressure Gauge, **Part# AJ496**, $2^5/_8$" Dia., $^1/_4$" NPT, 0-60in. H_2O and 0-150 mbar
- Pressure Gauge, **Part# AE133**, $2^5/_8$" Dia., $^1/_4$" NPT, 0-160in. H_2O and 0-400 mbar
- Pressure Gauge, **Part# AE133A**, $2^5/_8$ Dia., $^1/_4$" NPT, 0-200in. H_2O

- Vacuum Gauge, **Part# AJ497**, $2^5/_8$" Dia., $^1/_4$"NPT, 0-60in. H_2O and 0-150mbar
- Vacuum Gauge, **Part# AE134**, $2^5/_8$" Dia., 1/4"NPT. 0-160in. H_2O and 0-400 mbar

Pressure/Vacuum Relief Valve

- Pres/Vac Relief Valve, **Part# AG258**, $1^1/_2$" NPT, Adjustable 30-170 in. H_2O, 200 cfm max
- Silencer for Relief Valve, **Part# AJ121D**

TROUBLESHOOTING GUIDE

SYMPTOM	POSSIBLE DIAGNOSIS	POSSIBLE REMEDY
Abnormal Sound	Impeller damaged or contaminated by foreign material	Replace or clean Impeller, Install adequate filtration
Increase in Sound	Foreign material or heat can destroy muffler foam	Replace foam muffler elements, filter foreign material
Blown Fuse	Electrical wiring problem	Have qualified person check that impeller turns, check fuse, wiring diagram, or wiring capacity
Unit very hot	Running at too high a pressure or vacuum	Install a relief valve and pressure or vacuum guage

AUTHORIZED SERVICE FACILITIES

Gast Manufacturing Corp
9970 Red Arrow Hwy
Bridgman, MI 49106
TEL: 616-926-6171
FAX: 616-465-4300

Gast Manufacturing Corp
505 Washington Ave
Carlstadt, NJ 07072
TEL. 201-933-8484
FAX: 201-933-5545

Brenner Fiedler & Assoc.
13824 Bentley Place
Cerritos, CA 90701
TEL: 800-843-5558
TEL: 310-404-2721
FAX: 310-404-7975

Gast Manufacturing Co., Ltd
Beech House, Knaves Beech
Business Centre, Loudwater
High Wycombe, Bucks HP 10 9SD
England
TEL: 44 628 532600
FAX: 44 628 532470

Wainbee Limited
215 Brunswick Blvd.
Pointe Claire, Quebec
Canada H9R 4R7
TEL: 514-697-8810
FAX: 514-697-3070

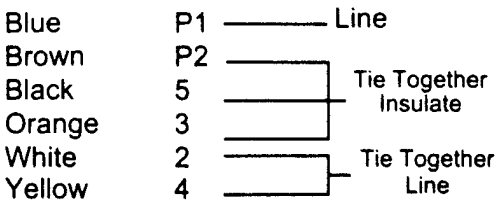
Wainbee Limited
5789 Coopers Avenue
Mississauga, Ontario
Canada L4Z 3S6
TEL: 416-213-7202
FAX: 416-213-7207

Japan Machinery Co. Ltd.
Central PO Box 1451
Tokyo, 100-91 Japan
TEL: 81-3-3573-5421
FAX: 81-3-3571-7865
or: 81-3-3571-7896

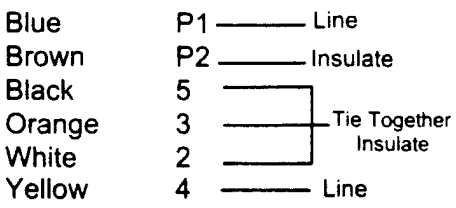
NOTE: General Correspondence should be sent to –
Gast Manufacturing Corp
P.O Box 97
Benton Harbor, MI 49023-0097

Wiring Diagrams for Regenerative Blower Models R1102, R2103, R2105, R3105-1, R3105-12, R4110-2, R4P115, R5125-2, R6125-2

Low Voltage - *Single Phase*



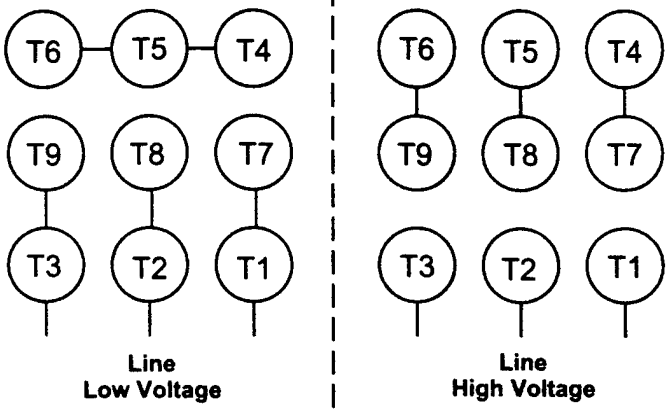
High Voltage - *Single Phase*



Models R2303A, R3305A-1, R3305A-13, R4310A-2, R4P315A, R6350A-2, R6P350A, R6PP3110M, R6PS3110M, R7100A-3, R7P3160M, R7S3160M

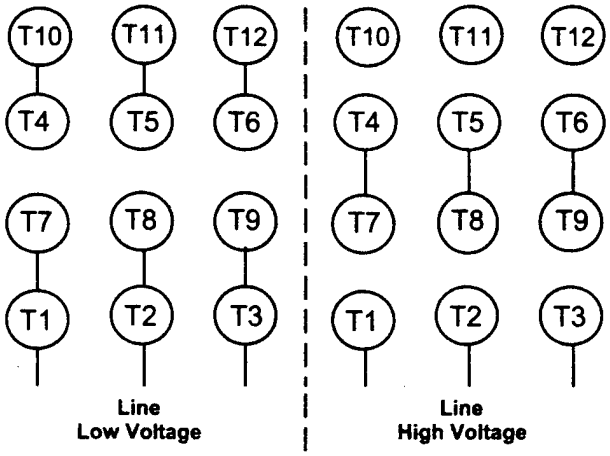
NOTE: Model **R6P355A** has two additional leads labeled "J" for an external thermal motor protection circuit.

Connections for 3 Phase, 9 Leads



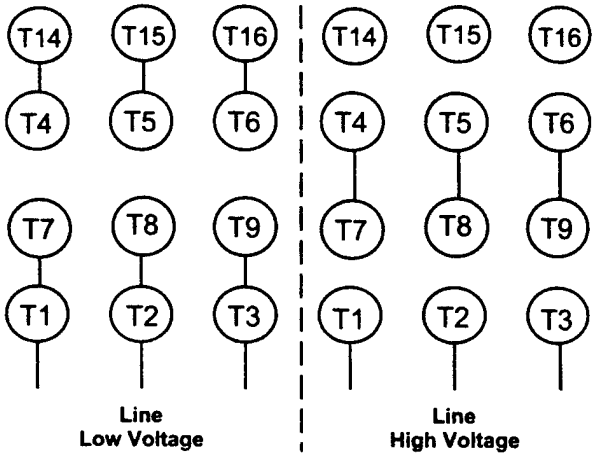
Models R6335A-2, R6P335A

Connections for 3 Phase, 12 Leads



Models R5325A-2, R6325A-2

Connections for 3 Phase, 12 Leads



To reverse rotation on any three phase motor, interchange any two external motor line connections to any two line leads.

Post Office Box 97
Benton Harbor, Michigan
Ph: 616/926-6171
Fax: 616/925-8288

PART NUMBER: LTD157

Product Specifications

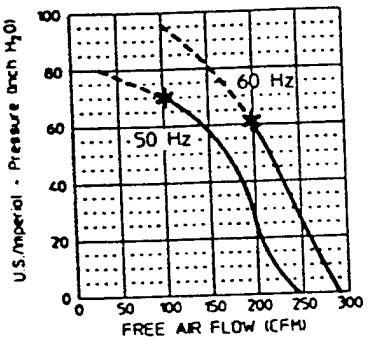
ECN# 24516 REVISION: B

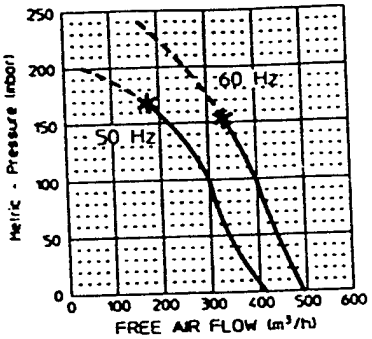
MODEL NUMBER	MOTOR SPECIFICATIONS	RPM	MAX VAC		MAX PRESS		HP	kW	NET WT.	
			"H_2O	mbar	"H_2O	mbar			lbs.	kg
R6P350A	190-220/380-415-50-3	2850	70	174	70	174	4.8	3.6	176	80
	208-230/460-60-3	3450	70	174	60	149	5	3.7		

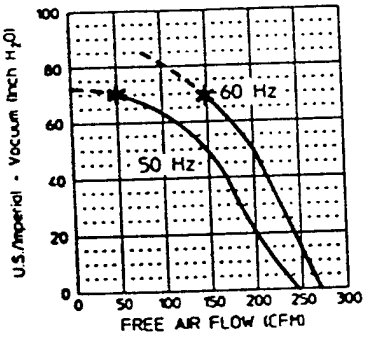
SOUND LEVEL 79/73 dB(A) MAX. @ 60/50 Hz
NORMAL AMBIENT -29°C TO 40°C
RELATIVE HUMIDITY 0% - 100% NON CONDENSING
ENVIRONMENT CLEAN DUST FREE

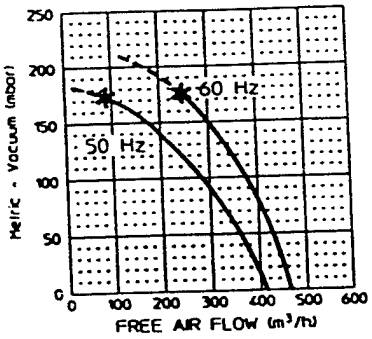
TECHNICAL DATA SUBJECT TO CHANGE WITHOUT NOTICE.

Product Performance (Metric U.S. Imperial)









PERFORMANCE DATA
THE PERFORMANCE DATA SHOWN WAS DETERMINED UNDER THE FOLLOWING CONDITIONS:

LINE VOLTAGE @ 60 Hz. 230V OR 460V FOR 3 PHASE UNITS. 115V OR 230V FOR 1 PHASE UNITS.

LINE VOLTAGE @ 50 Hz. 220V FOR 3 PHASE OR 1 PHASE UNITS.

UNITS IN A TEMPERATURE STABLE CONDITION.

DELIVERY MEASUREMENTS MADE WITH OUTPUT PORT THROTTLED.

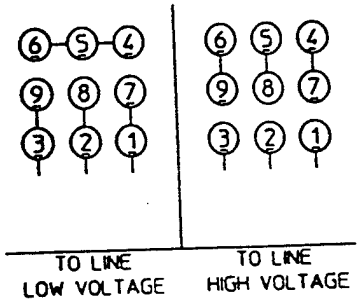
SUCTION MEASUREMENTS MADE WITH INPUT PORT THROTTLED.

TEST CONDITIONS: INLET AIR DENSITY @ 0.075 lbs. per cu. ft. [20°C (68°F), 29.92" Hg (14.7 PSIA)].

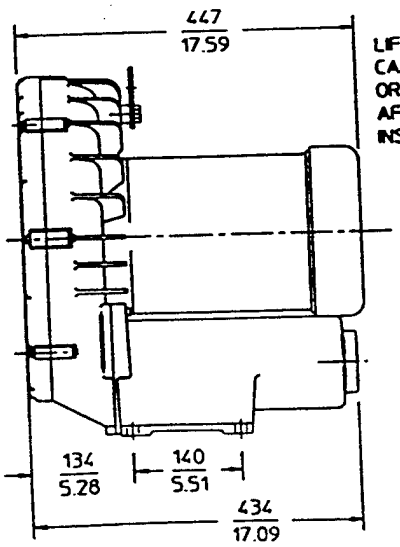
NORMAL PERFORMANCE VARIATIONS ON THE RISISTANCE CURVE WITHIN ±10% OF SUPPLIED DATA CAN BE EXPECTED.

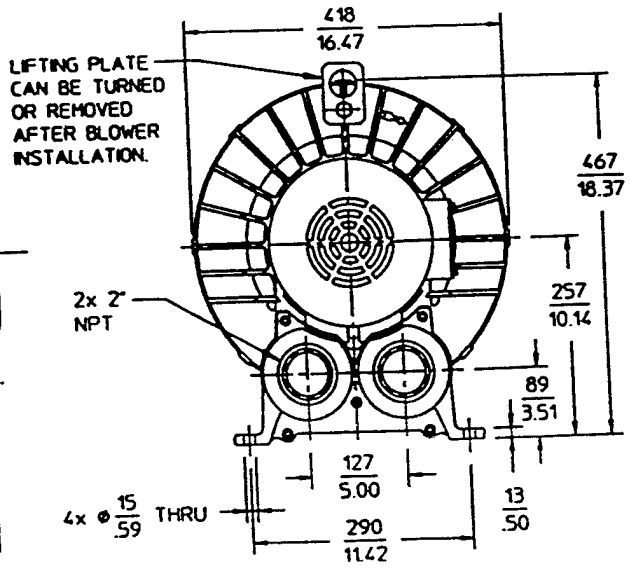
✱ DENOTES RECOMMENDED MAXIMUM DUTY

- - - - INTERMITTENT DUTY ONLY



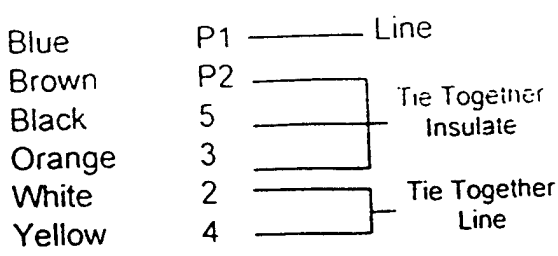
Product Dimensions Metric (mm) U.S. Imperial (inches)



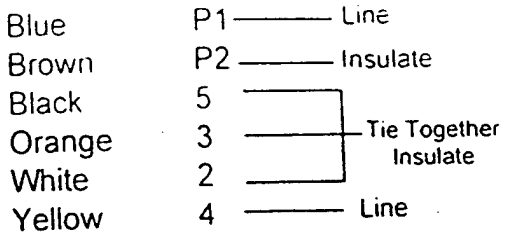


Wiring Diagrams for Regenerative Blower Models R1102, R2103, R2105, R3105-1, R3105-12, R4110-2, R4P115, R5125-2, R6125-2

Low Voltage - *Single Phase*



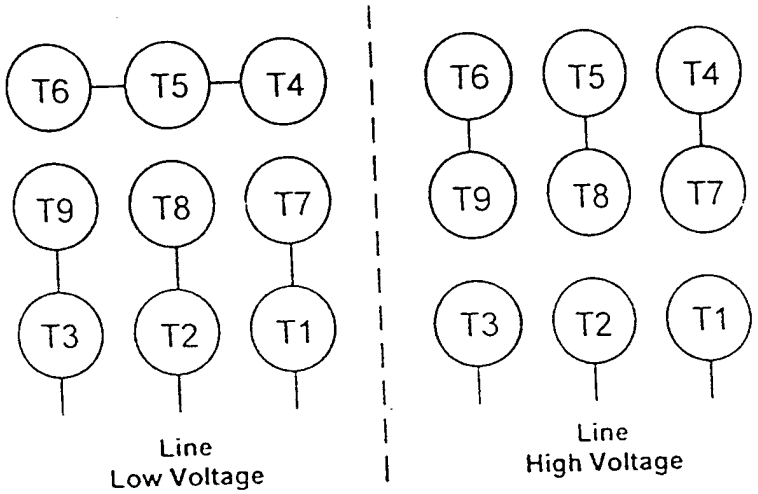
High Voltage - *Single Phase*



Models R2303A, R3305A-1, R3305A-13, R4310A-2, R4P315A, R6350A-2, R6P350A, R6PP3110M, R6PS3110M, R7100A-3, R7P3160M, R7S3160M

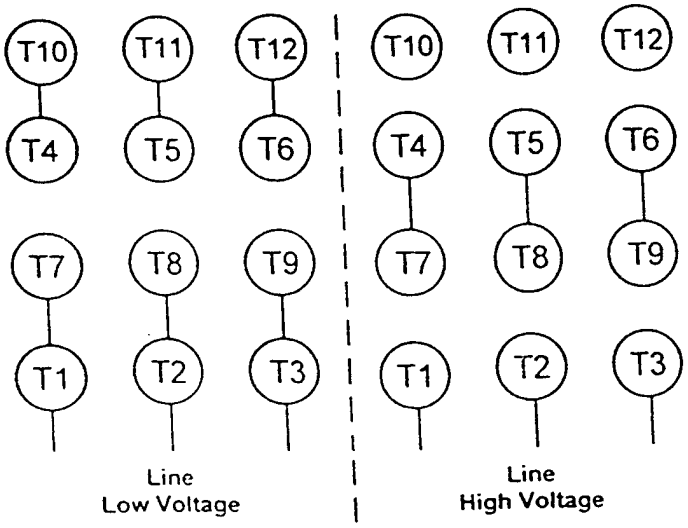
NOTE: Model R6P355A has two additional leads labeled "J" for an external thermal motor protection circuit.

Connections for 3 Phase, 9 Leads



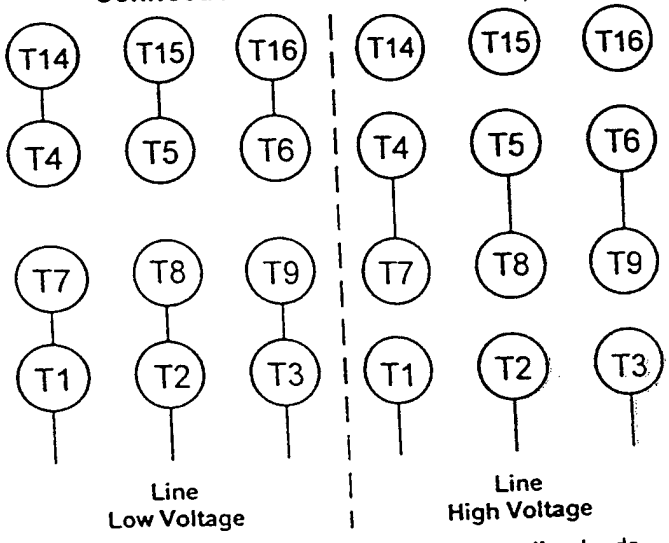
Models R6335A-2, R6P335A

Connections for 3 Phase, 12 Leads



Models R5325A-2, R6325A-2

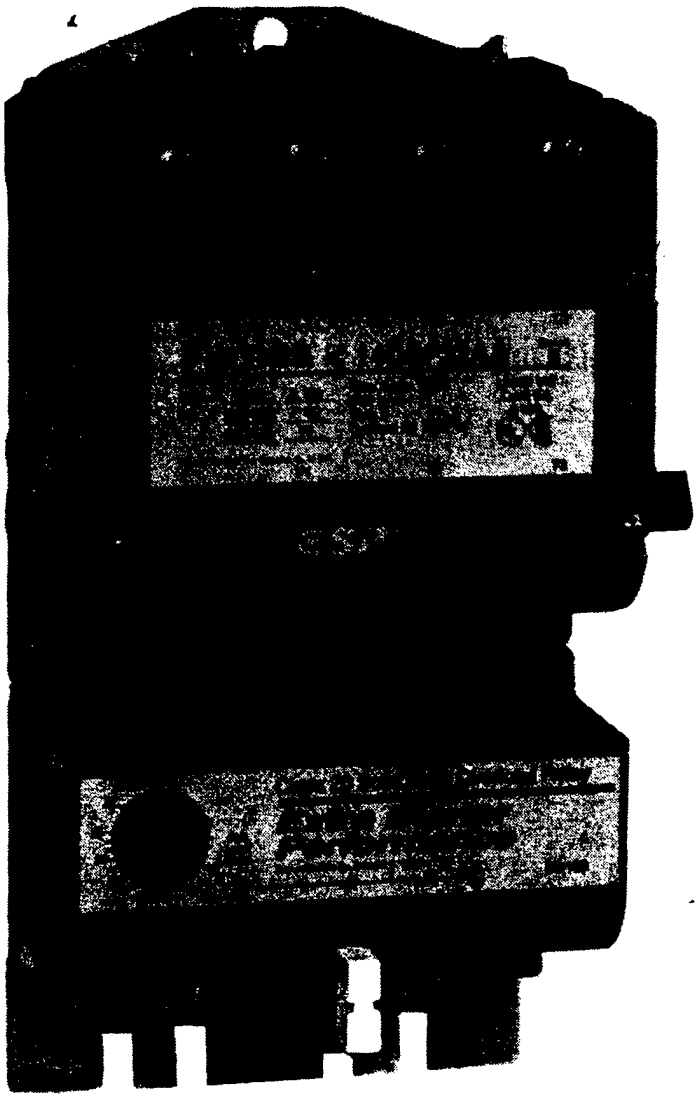
Connections for 3 Phase, 12 Leads



To reverse rotation on any three phase motor, interchange any two external motor line connections to any two line leads.

Protecting Your Motor with

ESP100™



Furnas

Furnas

The Right Choice

ESP100™

NEMA rated starter with a solid state overload for extra starter performance and even greater motor protection.

- Heaterless Construction
- True Phase Loss Protection
- 2:1 FLA Adjustment Range
- NEMA Sizes 0-6

Easily Replaces Sizes 0-1:

Cutler Hammer Allen Bradley
Square D Westinghouse
GE

Congratulations!

You have purchased the world's finest industrial motor starter—the Furnas ESP100. It's a state-of-the-art device offering extra starter performance by combining a rock-solid NEMA rated contactor with a solid state overload relay.

Development of ESP100 is based on years of research and experience in electronic, melting alloy and bimetal overload relays. The result is unprecedented motor protection.

This unique technology comes from our desire to provide you with the best possible control for heavy duty motor applications. This guide was written to help you take full advantage of the increased motor protection provided by ESP100—the first major advancement in NEMA rated starters in more that 20 years.

Problem-Solving ...at a Glance

When the ESP100 Trips... First, check amps in all 3 phases.

When the 3 phase currents are balanced...

If trip is on start up...

1. Check for proper class of overload. Class 20 is the recommended protection for most American motors (see below for more details).

2. Make sure load is not too heavy for motor to handle.

3. Adjustable frequency drives or DC injection (electronic) brakes will cause nuisance tripping.

4. The overload may be misadjusted (see below right for the details).

If trip is during normal operation...

2. Make sure load is not too heavy for motor to handle.

3. Adjustable frequency drives or DC injection (electronic) brakes will cause nuisance tripping.

4. The overload may be misadjusted (see below right for the details).

5. Check for the correct overload adjustment when using the looping option. Multiply the FLA by the number of times the motor lead passes though the sensing window to determine the proper adjustment.

When the overload trips within 3 seconds on start up...

If there is current in 2 phases only...

6. Phase loss is in the motor branch circuit (the motor is single phased).

Restore 3 phase power.

Tools needed:

Clamp-on ammeter, continuity checker and tools to tighten connections.

If there is a severe phase imbalance...

7. Current is present in all 3 phases, but large differences (2:1) exist between the phases. This may indicate a loss of phase ahead of the motor branch circuit or a damaged motor.

Restore missing primary phase or repair/replace motor winding.

(For more detailed information, see following pages.)

Always check for proper class of overload:

A key ingredient in protecting a motor is the selection of the class of overload relay for the acceleration time of the motor and its FLA (Full Load Amperage). An overload relay may trip before the motor accelerates to its full rated speed if starting current extends beyond the overload relay trip curve. Using a class of overload too fast to allow the motor to accelerate to full speed will cause nuisance tripping. Change to the correct class of overload relay (i.e. Class 10 instead of Class 20).

When the overload is adjusted too low:

A. ESP100 is very accurate, taking up to 6 or more clicks of the dial to cover the same range as one heater coil. Adjusting upward just one or two clicks may solve the problem.

B. Some applications take advantage of the motor service factor, or a short load cycle versus a long unloaded cycle, to operate the motor at currents above the motor FLA. The NEC 430-34 allows an overload setting of up to 10% over motor FLA if the motor cannot be started or run at the motor FLA setting.

1. When ESP100 trips on startup

Various types of motors require different types of overload relays to provide adequate protection. There are three different levels of overload relay protection available. These levels are differentiated by the assignment of a trip "class" number as follows:

Class 20 is the designation assigned to a "standard trip" overload relay and is designed to protect standard industrial motors including T-frame motors. Most NEMA rated General Purpose motors will be protected by a Class 20 overload relay.

Class 10 or "quick trip" overload relays are designed to protect low thermal capacity motors. Examples would include motors used for hermetic refrigeration compressors, submersible pumps and similar applications.

Class 30 refers to "slow trip" overload relays which are designed to protect *special* motors driving high inertia loads (long start up times). Some examples include ball mills, reciprocating pumps, loaded conveyors, etc.

The time required for an overload relay to trip under locked-rotor (stalled) motor conditions is ideally the time that permits use of the available motor horsepower and starting torque. The overload must allow sufficient time for the motor and its load to accelerate to rated speed. Nuisance tripping occurs when an overload relay, or its adjustment, is selected that does not allow the motor to reach proper operating speed or performance ratings. This may cause the user to adjust the FLA upward, which will result in reduced protection.

Section 430-34 of the National Electric Code (NEC) permits a user to adjust the overload relay 10% higher than appropriate for the motor FLA, under certain conditions. These conditions include (a) when the properly adjusted overload relay trips before the motor can accelerate to its rated speed, and (b) provided the overload relay is adjusted no greater than 130% of motor FLA for service factor 1.0 motors, or not greater than 140% of motor FLA for motors with a service factor of 1.15. Rather than give up running protection by adjusting the FLA, a user should select a higher class of overload relay. This will provide more time for motor and load acceleration, yet retain the level of overload protection specified by the NEC. The graph (Fig. 1) illustrates the danger of an overload relay class that is too fast for its motor.

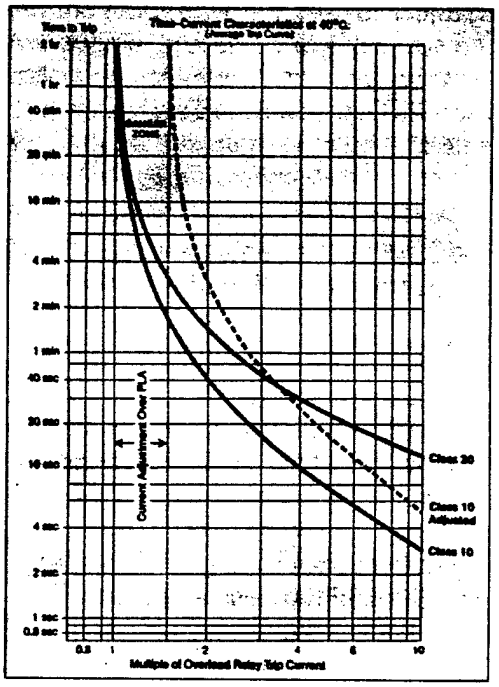


Fig. 1 Dangers of adjusting an overload relay above the FLA of the motor to prevent nuisance tripping on start up. Trip curve moves to the right and lessens or negates motor running protection.

2. Motor Overloaded

An electric motor is not capable of knowing when it is being worked too hard. If a load placed on a motor is too great, it will simply draw extra current and continue to handle the increased load. If this situation persists, it will eventually cause the overload to trip.

In contrast, temporary overloads may be handled easily if brief enough in duration to not cause overheating.

Typical overloading is caused by problems such as increased friction (bad bearings, poor lubrication, etc.), over feeding machinery (too heavy a cut, excess material, etc.) or too heavy a weight (conveyors, cranes, etc.).

The solution is to locate and remove the cause of the overload. The motor must also be allowed to to cool down before a restart is attempted.

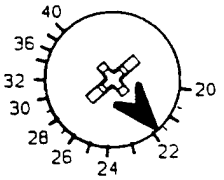
3. The ESP100 overload is rated 50/60 Hertz, AC only

Other frequencies will change the calibration of the overload relay and possibly cause nuisance tripping. A DC injection brake will be mistaken by the overload relay for a phase loss condition and will subsequently cause tripping. The ESP100 *should not* be applied on circuits containing adjustable frequency drives or DC injection brakes. The ESP100 *can be* applied with a soft start or solid state starter rated 50 or 60 Hertz.

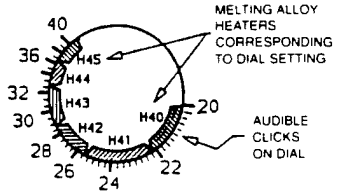
4. Overload Misadjustment

There is a tendency to set the current adjustment of the ESP100 overload relay *too low*. This is contrary to most people's experiences with thermal overload relays, which if misadjusted tend to be set *too high*. In fact, on retrofit applications in which oversized heater coils are used to prevent nuisance tripping, there is still a tendency to adjust the overload to less than motor rated full load current. *There seems to be a misconception that the high accuracy of a solid state overload relay necessitates setting the current adjustment below the motor's rated FLA.* This practice certainly protects the motor, but will not allow the motor to be used up to its rated horsepower.

Heater coils for thermal overload relays are sized in 10% steps. The adjustable ESP100 can have as many as 6 or more settings (clicks) to cover the same current range as one heater element. Adjusting upward one or two clicks tends to solve a nuisance tripping problem. This has been found to be particularly true on punch presses and other types of machinery where die sizes can vary widely and jogging set up may be necessary.



TYPICAL SOLID-STATE OVERLOAD ADJUSTMENT DIAL MARKINGS



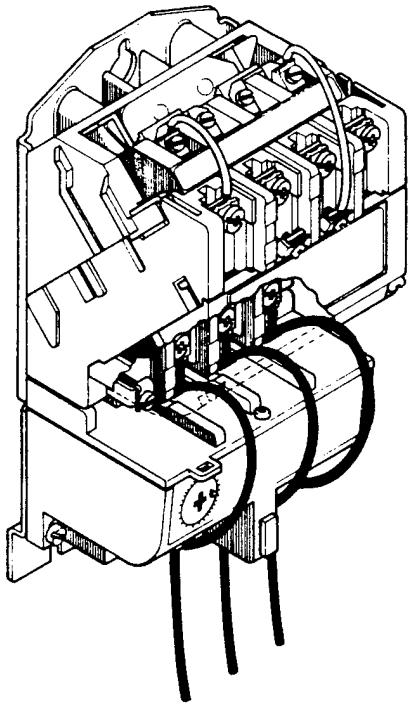
Other factors to consider:

1. Was the overload relay set to the maximum motor load? It has been found that when the overload relay was initially set with a small die in a press, it later tripped when the largest die was in operation. **Remember** that as many as 6 clicks of the ESP100 adjustment dial equals the same current range as one heater coil.

2. Some machinery or applications make deliberate use of the service factor of the motor to operate the motor temporarily or continuously at currents above the motor's rated FLA. Theoretically a motor may be used continuously at its service factor without harm (i.e. a motor with a service factor of 1.15 being used at 115% of rated FLA). This type of motor application is found on conveyors, air compressors, and light duty machinery. The ESP100 overload must be set at the motor FLA actually being used.

3. The duty cycle of the application may have allowed the use of an undersized motor to withstand short overloads providing the loaded cycle is not long enough to overload the motor.

5. Correct overload relay adjustment when using the looping option



Math errors being common, it is always worth double checking to see that the ESP100 overload relay has been adjusted properly when using the looping option. By passing the current to the motor through the ESP100's sensing windows more than once the current range can be extended downward. This allows the overload relay to sense two, three, four, or more times the current which is actually flowing to the motor. Using this option does not decrease motor protection in any way.

The easiest way to determine the correct ESP100 setting is to multiply the motor FLA by any whole number which falls within the current adjustment of the relay. For example, you have a motor rated at 5 full load amps and a 9-18 amp ESP100 overload relay. Five amps times two equals ten amps so that the motor loads can be **looped once** around the relay and the motor lead passes through the sensing window twice. The correct ESP100 setting would be 10 amps as the overload relay is sensing twice the 5 amps the motor is drawing. Using the same motor and relay as an example, the motor leads could be **looped twice** so that they pass through the sensing window three times (5 amps x 3 = 15 amp setting) and the correct ESP100 overload relay setting would be 15 amps.

The following table demonstrates how the looping process reduces the current setting of the overload by the number of times the wires pass through the windows of the overload.

All current values are expressed in Amps.

	Overload Current Range	# of Loops	# of Times Wire Passes Thru Window
Shown on label	9-18	0	1
	4.5-9.0	1	2
	3.0-6.0	2	3
	2.25-4.50	3	4
	1.80-3.60	4	5
	1.50-3.00	5	6

6. Phase loss (only 2 of 3 phases present)

Phase loss as used in this guide refers to a loss of a single phase of a three phase motor branch circuit. The ESP100 is designed to react to phase loss within three seconds. A continuity check will normally pinpoint this problem quickly. The most typical cause of phase loss is a blown fuse. Single phasing is an important cause of motor failure and deserves immediate attention.

7. Severe Phase Imbalance

In this situation there will still be current in all three phases, but large differences (2:1) exist between the phases. The most likely two causes of this situation are:

A. *Loss of phase in the primary of the circuit.*

For example one of the test manufacturing plants was operating on a severe phase imbalance due to a loss of phase in the utilities power lines. The operating motors in the plant then acted as generators and produced some current in the missing phase. Overload relays are *not* designed to protect against phase imbalance. Various phase monitoring relays on the incoming power lines is perhaps the most popular way to provide this protection.

B. *A damaged or defective motor winding can also be the cause of severe current imbalance.*

During one in-plant test, two motors with damaged windings were found. One had a 51.5% current imbalance. These damaged motors were operating completely undetected by thermal overload relays. The ESP100 allowed the defective motors to be pinpointed and repaired or replaced before they could burn out at a critical time.

ESP100 Specifications

- Available in NEMA Sizes 0-6 (0-4 on self-reset)
- Dual voltage coils readily available
- Front mounted auxiliary contacts
- Common coil for Sizes 0-2½
- Snap-in coil through Size 4
- Encapsulated coils on all sizes
- Inspectable contacts through Size 4
- Replaceable contacts on all sizes
- Key hole/slot mounting through Size 4
- Trips in 3 seconds on phase loss condition
- Class 10, 20 or 30 overload protection
- NO or NC isolated alarm contacts for overload relay*
- Trip free overload mechanism*
- Overload contact test function*
- Tamper proof cover for overload dial
- 4:1 FLA adjustment range up to 10A, 2:1 above 10A
- Visible trip indication on overload relay*
- Overload relay is impervious to short circuit currents
- Thermal memory on overload relay
- NEMA A600 contacts on overload relay (NEMA B300 on self-reset)
- Sizes 0 & 1 provide mounting dimensions of competitive devices for easy retrofitting
- Heaterless construction
- Ambient insensitive
- Overload relay is close coupled to contactor - not panel mounted
- Overloads above 10A can be looped to extend range to 4:1 for more versatility

* Not available on self-reset versions

NOTES

Furnas

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Furnas

ESP100™

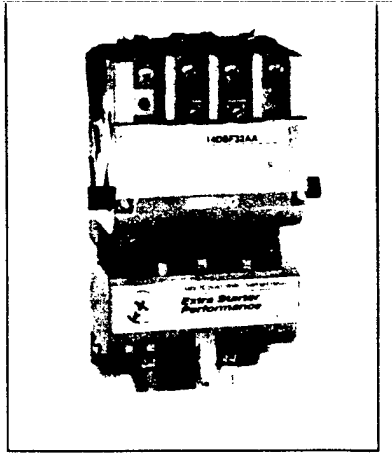
REPLACEMENT PARTS

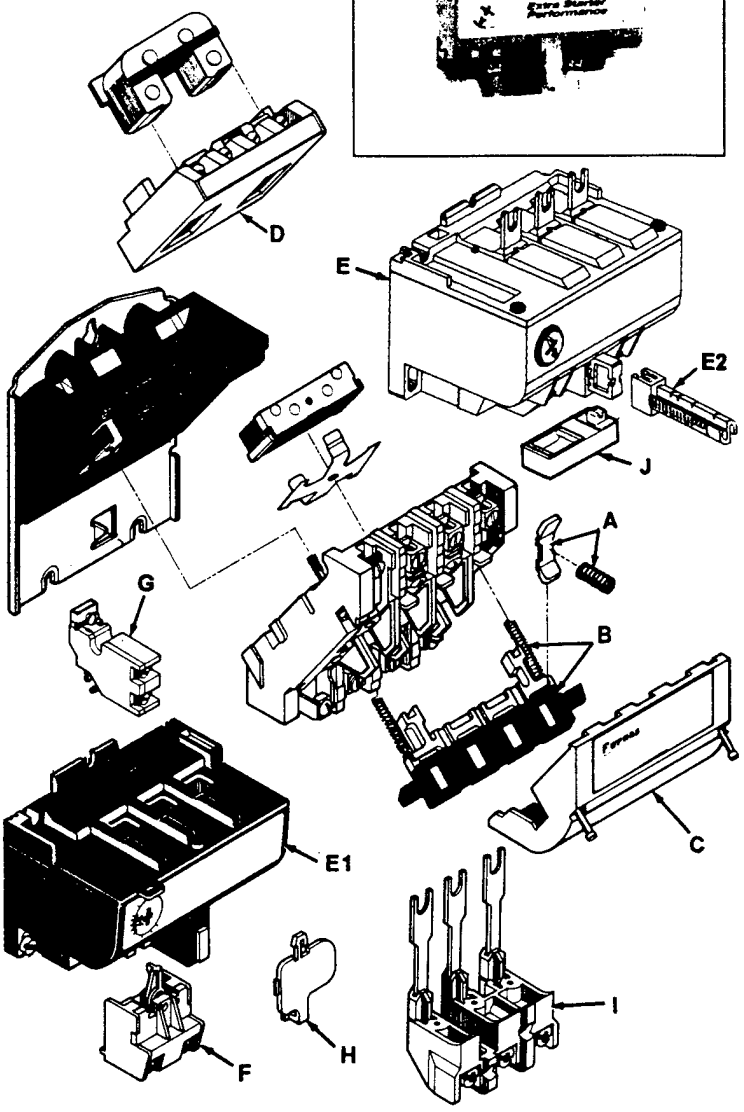
Class 14
Starters & Contactors
Sizes: 0, 1 & 1¾
14CS, 14DS, 14ES

14-GES 9/94

Furnas

September, 1994
Supersedes Issue of
July, 1993





9/94

Starters & Contactors
0, 1 & 1 3/4

Class 14
14CS, 14DS, 14ES

Item	Part Description			Part Number
A	Contacts & Spring, One Complete Pole			
	Power Pole	Size	0	75CF14
			1	75DF14
			1¾	75EF14
	Interlock Pole (includes spring retainer)	All Sizes		75AF14
B	Cross Arm (less contacts) With Cross Arm Springs			75P1000
C	Contact Board Cover			D29079001
D	Coil			
	60 Hertz	50 Hertz		
	120V	110V		75D73070F
	110-120V/220-240V	110V/190-220V		75D73070A
	220-240V/440-480V	190-220V/380-440V		75D73070C
	550-600V	550V		75D73070E
	(For other voltages specify the number stamped on the coil).			

E Overload Relays - 3 Phase

Size	Amps	Class 10	Class 20	Class 30
0, 1	0.25-1	48ASA3M10	48ASA3M20	48ASA3M30
0, 1	0.75-3	48ASB3M10	48ASB3M20	48ASB3M30
0, 1	2.5-10	48ASD3M10	48ASD3M20	48ASD3M30

Overload Relays - Single Phase

0, 1	0.75-3	48ASB1M10	48ASB1M20	48ASB1M30
0, 1	2.5-10	48ASD1M10	48ASD1M20	48ASD1M30
0, 1	5.0-16	48ASE1M10	48ASE1M20	48ASE1M30

E1 Overload Relays - 3 Phase

Size	Amps	Class 10	Class 20	Class 30
0, 1	3-6, 5-10	Old style *(use styles on above table)*		
0, 1	9-18	48ASE3M10	48ASE3M20	48ASE3M30
1, 1¾	13-27	48ASF3M10	48ASF3M20	48ASF3M30
1¾	20-40	48ASG3M10	48ASG3M20	48ASG3M30

E2	Reset Extender			49ASRE
F	Auxiliary Contact Overload Kit-NO Contact			49ASNO
			NC Contact	49ASNC
G	Front Mtg. Auxiliary Interlock SPST-NO			49AAFO
			NC	49AAFC
H	Tamper Resistant Cover	9-40A		49ASTC
I	Lug Extender (Size 0, 1)	9-40A		49ASLE
J	Dust Seal			49ASDS

NOTE: When ordering replacement parts, give catalog number of control and part name and number.

EASY INSTALLATION GUIDE

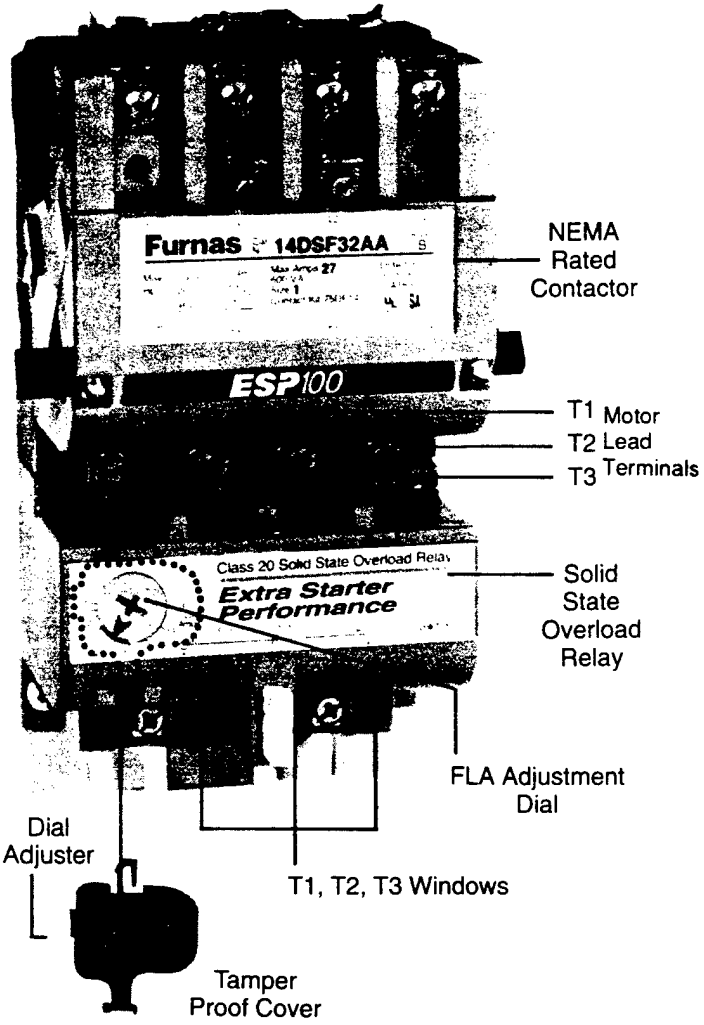
ESP100™

Furnas

14-HES 6/93

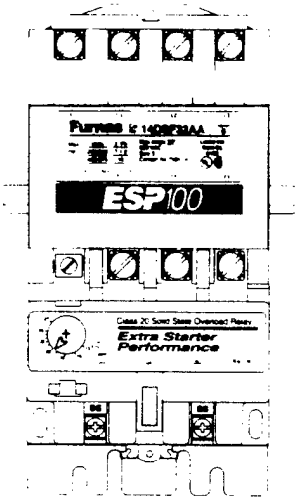
ESP100™

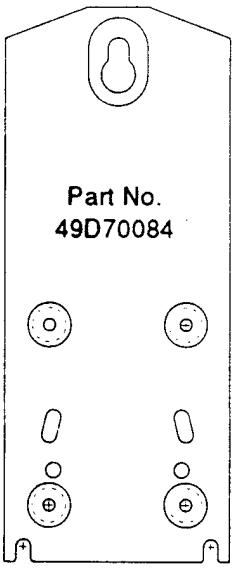
EASY TO INSTALL. EASY TO MAINTAIN.



1 MOUNTING

No drilling required for retrofitting:





The Furnas ESP100 FVNR size 0-1¾ have as standard universal mounting which fits the following:

Cutler Hammer-
Citation Series
Freedom Series

GE- 300-Line

Square D- Type S

An additional adapter plate is required to retrofit the following:

Allen Bradley- Bulletin 509
Bulletin 709

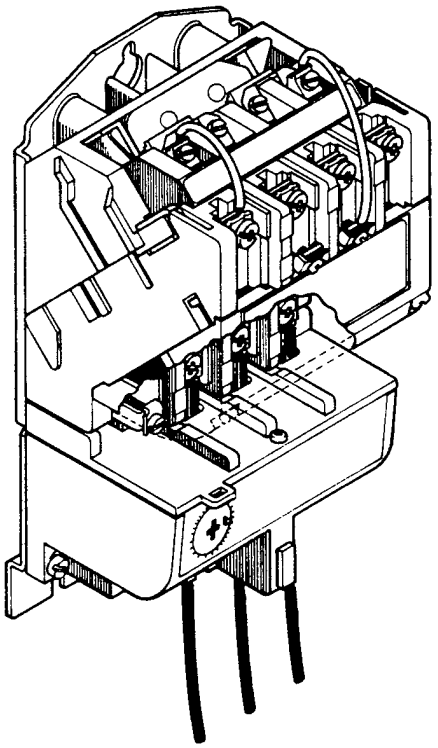
Westinghouse- Series A200

The ESP100 with its existing backplate mounts onto the piggy back mounting plate and is secured in place with three mounting screws.

2 WIRING

Push one motor lead through each pass-thru window in the overload and connect to terminals T1, T2 and T3 on the contactor.

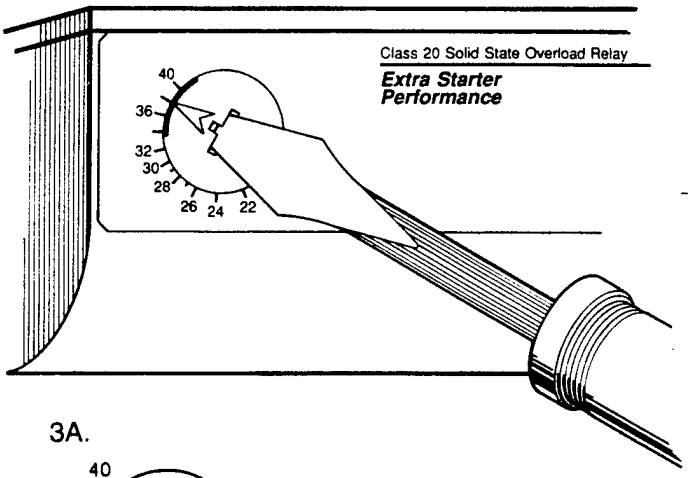
For contactor, wire per enclosed wiring diagram.
Use with 3 phase motors at 50 or 60 Hz only.



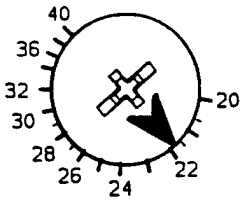
3 FLA ADJUSTMENT

Set the adjustment dial on the overload to the Full Load Amps on the motor nameplate.*

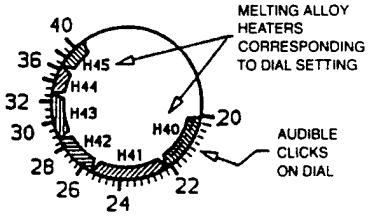
In addition to the markings on the dial there are audible clicks which allow for extremely fine tuning. Note that while thermal overloads require a heater selection based on a relatively wide ampere range the overload on the ESP100 will have many clicks covering the same ampere range. See Figure 3A.



3A.



TYPICAL SOLID-STATE OVERLOAD ADJUSTMENT DIAL MARKINGS



*Service factor 1.0 = amps x 0.9

TROUBLE SHOOTING

Hot Terminals	Loose connections. Clean connections and tighten.
Failure to trip out (causing motor burnout)	Incorrect current adjustment. Readjust to motor full load amperes found on the motor nameplate.
Overload Trips	
1. Motor Overloaded	Remove cause of overload and reset.
2. Loss of Phase	Replace fuse or reconnect missing phase.
3. Dial Adjusted Too Low	Readjust to motor name-plate amperes.

ACCESSORIES

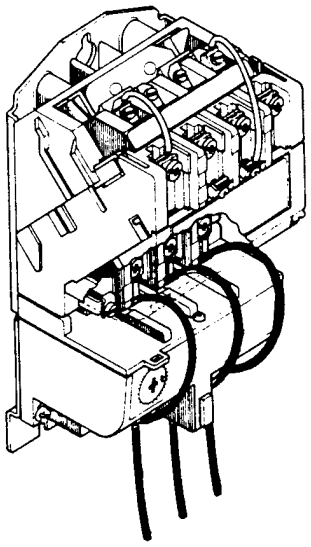
Safety Cover: Fitted cover plate may be closed with wire seal to prevent unauthorized tampering with FLA adjustment dial of solid state overload relay. 49ASTC (Pkg. of 10)

Auxiliary Contact Block: NO or NC block for use with ESP100's overload to signal remote alarms or other devices. 49ASNO 49ASNC

Reset Button Extender: Permits use with Furnas System 89 MCC's and extra deep enclosures. 49ASRE

Furnas Electric Company
1000 McKee Street, Batavia, IL 60510
(708) 879-6000, FAX (708) 879-0867

LOOPING OPTION



In applications involving use of 12-14 gauge wire, usually motors of 5 HP or less, the wires may be looped and passed a second time through the windows before wiring to the contactor. By looping the motor leads through the windows in the overload, the overload will read twice the current actually going to the motor. Hence the overload can protect a motor needing half the FLA current capability of the overload; An overload with a current range of 9-to-18 amps can be used for a motor requiring from 4.5 to 9 FLA.

Similarly, motors that require only one-third, one-fourth, or one-fifth the overload's FLA current capability can use the same size ESP100 starter by looping three, four or five times.

The following table demonstrates how the looping process reduces the current setting of the overload by the number of times the wires pass through the windows of the overload.

All current values are expressed in Amps.

	Overload Current Range	# of Loops	# of Times Wire Passes Thru Window
Shown on label	9-18	0	1
	4.5-9.0	1	2
	3.0-6.0	2	3
	2.25-4.50	3	4
	1.80-3.60	4	5
	1.50-3.00	5	6

How to wire for

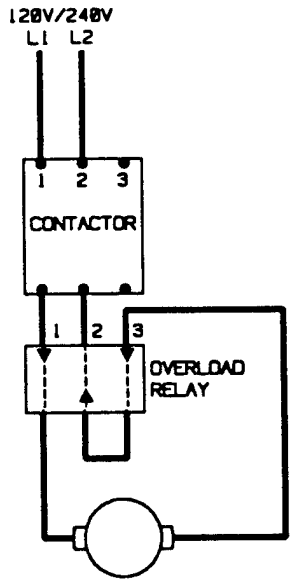
SINGLE PHASE MOTOR

The ESP100 design is a 3 pole device intended for use with 3 Phase motors. However, as a convenience it can be wired to accommodate Single Phase motors.

For an *approximate* setting of a Single Phase motor application, multiply the motor nameplate by **.75** and set the dial on the overload to the resulting value.

Warning: The device must be wired with polarity as shown. Neutral and LI wires must be wired as indicated on the drawing, polarity is indicated by ⬇⬆.

Single Phase Connection Diagram



APPENDIX C

DATA COLLECTION SHEETS

DATA COLLECTION SHEET
REGENERATIVE BLOWER SYSTEM
EGLIN MAIN BASE OLD FIRE TRAINING AREA (SITE FT-28)
EGLIN AFB, FLORIDA

Date	Time	Blower Functioning Upon Arrival? (Y/N)	Inlet Vacuum (inches H_2O)	Outlet Temperature (°F)	Outlet Pressure (inches H_2O)	Comments	Checked by (Initials)

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